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MALIGNANT EFFECTS OF THE FREE-SILVER DELUSION.

By Edward Atkinson.

PROBABLY no class of persons in this country, without being subjected to absolute want, has suffered more for lack of customary occupation or employment since the panic of 1893 than that which comprises engineers, architects, draftsmen, and their assistants. The reason is very plain. One of the principal functions of this class of professional men is to lay out and conduct constructive work; to make provision for future need; to open the ways for an extension of the railway service; to plan and put up factories, industrial buildings, commercial warehouses, and the like,—to say nothing of dwelling-houses. The first effect even of a commercial crisis is to retard the progress of constructive enterprise. The most malignant effect of a purely financial crisis like that of 1893 is to almost stop constructive enterprise. The reason is clear. All branches of industry depend in great measure upon credit for their conduct, but all branches of constructive enterprise depend absolutely upon credit being granted to the future, not only in lending money, but in trusting that a demand for the service of such constructive work will arise.

It follows that the worst enemy of the engineer, the architect, and the draftsman is he who impairs the credit of the nation's unit of value. There is no class in the community more capable of measuring the malignant influence of the silver craze upon itself than this class, and there is no class of the community that would be more fully and surely justified in denouncing the advocates of the free coinage of silver.

There is one example which may be statistically measured. It is an example which has probably been least affected by the silver craze,

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and which perhaps, of all the branches of work named, gives the least employment to the engineer,—to wit, house-building. We may fairly compute the increase of population during the last two years of depression at exceeding three million persons. If we assign to each one of the three million a dwelling-place at a cost of $100, which would be at the rate of only $500 for a house or an apartment for a family of five persons, the expenditure for merely housing an additional three millions of people would amount to $300,000,000, and that would stand for the work of 500,000 lumbermen, brick-makers, lime-burners, wood-workers, carpenters, nail-makers, and the like, in addition to the work of many designers, architects, and draftsmen, at an average of $600 each. Taking this absolute need as a unit, and developing from that the increasing demand for work-shops, commercial warehouses, factories, and other buildings under normal conditions, one accustomed to dealing with such a subject may imagine the evil effect of retarding constructive enterprise or stopping adequate preparation for the future need of an increasing population, even for a short time. Another aspect of the case is that, in proportion as the constructive enterprise is stopped, the crowding of existing buildings is increased.

It is, of course, impossible to determine by figures what proportion of the working population of this country—mental, manual, and mechanical—is and must be engaged in constructive enterprise. From all the investigations which I have been able to make, I think that the proportion, under normal conditions, would be 10 per cent. of the whole number. It is approximately, if not exactly, true that 90 per cent. of the work of a great community is devoted to the immediate purpose of providing the means of living, while 10 per cent. may be devoted to the conversion of food, fuel, metal, and other materials into more or less permanent forms of capital for reproductive service. The end of all production is consumption. Consumption consists mainly in the mere support of life. The energy developed by way of consumption may, however, be in part, and in about the proportion of 10 per cent., devoted to the maintenance and increase of the capital of the nation. It is necessary to the orderly and normal conduct of business that both these processes of consumption should advance in due proportion and without serious interruption or retardation. It is a well established fact among business men that a difference of 5 per cent. in the production and consumption of the necessaries of life may have a much more than proportionate influence upon prices and occupations. A deficiency of 5 per cent. in any necessary article may advance prices in much greater measure. On the other hand, an excess of 5 per cent. forced upon the market may and often does depress prices in a vastly greater proportion than that. If, again, that excess is con-

tinuous, owing to a lack of consuming power, or to a reduction of the consuming power to a point below the normal, the influence becomes very malignant, and nearly all prices may for the time be forced below the cost of production,—the evil itself generating other evils of like kind in increasing proportion until the cause is removed.

Dealing with these general facts, then, let us review the recent period. Our population has ranged from sixty-eight to seventy million persons since the panic. Substantially one in three of the whole number is habitually occupied in gainful work,—mental, manual, or mechanical. The total number of workers of all kinds has therefore been about twenty-three million. If 10 per cent. of that twenty-three million should be, under normal conditions, occupied in constructive work, the total number in that class would be 2,300,000. Now suppose constructive work stopped only in the proportion of one-half. We should then have conditions under which more than one million persons would be wholly without work, and competing with all others for such work of that kind as might be found. Hence diminished consumption, production in excess of the demand, depression of prices, and discontent among the other 90 per cent., whose work is continuous, but may be performed at a loss for the time being, one class of course also competing with the other on the work which must be continuous.

Do not these theoretic conditions exactly correspond to the real conditions that have prevailed since 1893? The number of the absolutely unemployed has probably been greatly exaggerated. The number of those whose wages have been reduced has been exaggerated. Yet the privation has been very great, and the number of persons affected, even though a small proportion of the whole, has been very large. What caused the partial stoppage of constructive enterprise? Lack of credit. What caused the break in credit, the withdrawal of foreign capital, and the hesitation of the capitalists of this country to do anything with it? The silver craze,—nothing but the silver craze, and the danger that the unit of value of this country would be debased.

Who are the chief promoters of this fraud upon the community? There are admittedly a great many sincere and upright men who believe that a bimetallic system of coinage and of legal tender can be entered into by the great commercial nations of the world, under which agreement the two metals, coined in weights governed by a fixed ratio, can be kept at a parity. This class of advocates of the bimetallic or alternate legal-tender use of silver and gold are entitled to our respect, and are to be met by argument on the part of those who do not believe that under any agreement or treaty the value or intellectual estimation of silver can be kept equal to that of gold at a certain fixed ratio. It is not

with these men that the present issue is raised. The representatives of mining camps in our national senate, who command immense sums of money, who lend their own money on mortgage on a gold basis, the banks of whose States maintain a larger proportion of their reserves in gold than do any other banks of this country, and by whom every other interest of the country is made subordinate to this petty silver industry, are the men who must be marked down for public discredit, and be deprived of their malignant power in the senate of the United States.

Provision for the dwelling-place has been considered; we will now deal with the railway problem. Long before the panic of 1893 the speculative construction of competing railway lines and of parallel lines had come to its natural end, but the absolute necessity for the construction of railways in many parts of this country had not ceased. In fact, in many great sections it had hardly begun to be realized. For example, Texas covers an area substantially equal to that of West Virginia, Ohio, Illinois, Indiana, Wisconsin, and Iowa. These States already possess over 42,000 miles of railway. In Texas there are a little over 9,000 miles; yet the resources of Texas yet to be developed are equal, if not superior, to those of the several States I have named. No State has suffered, or will suffer, more from the free coinage craze than Texas. The perversion of her public men on this fallacy has destroyed her individual and corporate credit and kept capital out of the State, and will continue to do so. No sane man could be expected to lend capital now in his possession upon a gold basis to the people of a State who were so insane as to believe that they could rightly pay him off in silver dollars possessing a bullion value of only half the capital lent. Hence it follows that there has been, and is, little or no occupation for the engineer, the draftsman, the architect, and the professional man in Texas compared to what there might and ought to be. The same rule applies with more or less force to every State in which the public men who may be assumed to represent the average ignorance or intelligence of the people are supporters of the free coinage of silver.

The pretexts upon which the free-silver fraud is based are numerous. We will take up two or three of the most prominent. First, the claim has been made that we must protect the silver industry; and by every possible method people have been deceived and misled as to the magnitude of this industry. In the census of 1890 there is a complete report of the facts of the silver industry. They are substantially as follows: it gave employment in the year for which the census was taken to a little force of about thirty three thousand men, earning average wages as compared to other classes in the community working under similarly arduous conditions. About half the number were engaged in the development of silver ores, from which

about half the silver bullion product was derived. The other half was derived from copper and lead ores,—the silver to a certain extent, sometimes to the full extent, being a by-product, and in some cases costing nothing because the principal product paid a profit on its own production.

It is doubtless true that great improvements have been applied to the production of gold as well as of silver, assuring an absolute abundance of gold for any length of time which it is worth while to consider. All the predictions of Professor Seuss and other so-called authorities of the falling off in the gold product have been discredited by the fact of an abundant increase. It is, however, manifest that the applications of science and invention, and the discovery of mines and deposits of silver, have had a far greater effect upon the silver product than have any corresponding influences upon the gold product. In order to prove these statements, reference needs only to be made to the estimates of the world's production of gold and silver from 1870 to 1894 inclusive, given by the director of the mint.

Years.	Gold.	Silver.
1870	$106,850,000	$ 51,575,000
1871	107,000,000	61,050,000
1872	99,600,000	65,250,000
1873	96,200,000	81,800,000
1874	90,750,000	71,500,000
1875	97,500,000	80,500,000
1876	103,700,000	87,600,000
1877	114,000,000	81,000,000
1878	119,000,000	95,000,000
1879	109,000,000	96,000,000
1880	106,500,000	96,700,000
1881	103,000,000	102,000,000
1882	102,000,000	111,800,000
1883	95,400,000	115,300,000
1884	101,700,000	105,500,000
1885	108,400,000	118,500,000
1886	106,000,000	120,600,000
1887	105,775,000	124,281,000
1888	110,197,000	140,706,000
1889	123,489,000	155,428,000
1890	118,849,000	163,032,000
1891	130,650,000	177,352,000
1892	146,298,000	197,741,000
1893	157,228,000	209,165,000
1894.....Approximate only	170,000,000	193,000,000*

It will be remarked that, in face of the depreciation in the value of silver relative to gold, the production of silver has gone on increasing

* The estimate of silver for 1894 is based on figures taken from *The Financial Chronicle.*

with scarcely any let-up, proving that there has been no cessation in the profit of this work when conducted on modern scientific methods. It will be plainly seen that at the rate of progression indicated by these figures there could be no safety whatever on the part of any country in continuing to maintain silver as its standard of value. Acts of legal tender, treaties and agreements would be equally powerless in the face of these data of production.

After 1878, when the compulsory purchase of silver bullion by the government began, great improvements were made in mining and metallurgy, corresponding to those which have been made in all other arts. The cost of the production of silver was reduced, but the demand was artificially kept up by the compulsory purchases of the United States. Since those purchases stopped, many mines have come to a standstill, and there was for a time a lack of employment in the silver-producing States among a small number of persons,—a mere fraction as compared to those who have been injured and who have suffered lack of employment under the domination of the promoters of the silver delusion among the people. It is now well known that this force has found work either in gold mining or other industries. The market value of the silver produced is trifling as compared to the total product of this country, and, as I have often had occasion to say, is equal now only to one-third to one-half the value of the annual product of hens' eggs. The attempt to set this industry up as one to which the great interests of the country should be rendered subordinate proves to be absurd, the moment the glamour which surrounds the mining of the precious metals is dispersed and the silver bubble is pricked. Aside and wholly separate from this attempt of the promoters of the silver industry to raise the price of silver at the cost of the country, an opinion is held by many sincere, but deluded, persons that the prices of other commodities, consisting of the necessaries, comforts, and luxuries of life, have been unduly depressed by the so-called demonetization of silver. Silver has not been demonetized anywhere, and the monetary use of silver is now larger than it ever was before. It has simply been displaced from its function of a full legal tender. The opportunity to do this was offered by the increasing abundance of gold, which, proving more suitable as a unit of value, has forced its way into the position of the world's unit of value in all international commerce, without regard to statutes or acts of legal tender of any kind. The production of gold is now greater than the production of gold and silver together were in 1871-3, and it is rapidly increasing. Gold itself has lost a part of its purchasing power. This can be readily proved by reference either to average or to particular prices. If we deal with the average price of commodities on a gold standard developed from Sauerbeck's tables,—

the authority of which is accepted by both parties in this controversy,—we find that the index number of prices in 1892 was substantially the same as it was from 1845 to 1849. By comparison with 1860 there has been an average reduction in prices in some measure, but not fully corresponding to the general reduction in the cost of labor and in the charge for distribution. By cost of labor I do not mean rate of wages. In all arts to which science and invention are applied the reduction in the cost of labor is effected by the relative rise in the rate of wages and in the purchasing power of wages. If we deal with each specific article of necessity or comfort,—food, fuel, fibre, or fabric,—we find that there has been no uniformity in the course of prices on a gold basis. The prices of a few articles have risen since 1873, in which year the high prices of the speculative era culminated, such articles having become relatively scarce in ratio to the increasing demand. Others, notably animal products, have maintained a fairly substantial average at about the same ratio, subject to but little reduction. This, again, is due to the increased consuming power of the masses of the people, who have thriven greatly upon the gold standard. A few other articles, notably wheat, have fallen materially. If, however, each of these classes or each particular article is dealt with separately, two facts are disclosed. First, that during a period of 25 years antecedent to 1873, in which the relative value of silver to that of gold was fairly uniform, there were as frequent or more frequent commercial crises, as great fluctuation in prices, and, at one time, a fall in prices very nearly to the present level, in the face of an increasing production of both gold and silver. The so-called bimetallic system had apparently little or no influence in maintaining uniform conditions in respect to prices and wages. Since 1873 the tendency has been to a reduction in prices corresponding in some measure, but not fully, to the reduced cost of production and distribution.

This phase of the subject especially interests the readers of an engineering magazine, and I would venture to suggest a research which I have not the time to conduct to its conclusion on the special applications of science and invention to the different arts. I will only deal interrogatively with the main subjects of consumption. Is it not true that an intelligent farmer can either derive double product from a given area of good land by the employment of the same number of hands that he employed in 1860, or derive an equal product from the same land at less than half the cost of labor and capital required at that date? In reply to this question the whole art of the engineer and inventor, as applied to agricultural implements, tools, and machinery, should be explored, and the influence of each invention on the cost of labor measured.

In metallurgy—notably in iron, and perhaps as much in copper—is it not true that double to treble as much can be produced to-day as in 1860, at one-third to one-half the cost, by the employment of the same quantity of labor, or even less, in any well-established mine, furnace, or works? Has not this improvement been accompanied by higher wages, the correlative of lessening cost of production?

A history of these and all other arts would develop the fact that any attempt to connect the price of silver with the change in the prices of food and metals other than silver would simply be an absurdity.

In dealing with wood-working, from the timber to the completed fabric; in dealing with the milling of grain; in dealing with the making of paper,—have not complete revolutions been brought about by science and invention, doubling the product per unit of labor, or trebling it; saving that which had been wasted; increasing the abundance; lessening the price; raising the wages; and, while diminishing the margin of profit, leaving great aggregate profits to the benefit of those who conduct the work? In fact, let any intelligent person take up every branch of the production of food, textiles, metals, and the like; while he will find that the influence of reductions in taxation has been considerable,—especially that effected by the removal of duties on the import of materials necessary to the processes of our domestic industry,—he may be challenged to name a single product of any considerable moment of which the supply and demand or the price have been influenced in any permanent or considerable measure by the variations in the ratio of the value of silver bullion to gold bullion. There have been temporary disturbances in the conduct of commerce between the gold-standard States and the silver-standard States, but, unless the absurd position is taken that a depreciation of the currency is a benefit to the country which is subjected to it, it will be impossible for the advocates of the free coinage of silver to prove that there has been any benefit from the depreciation of silver to any of the silver-using States,—India, China, or any other country. On the contrary, they have been subjected to many hardships which the advocates of the free coinage of silver are now attempting to bring upon our own country for their own selfish purposes of private greed and private gain.

The end of the question has really come. The solid sense of the country has been aroused, and under the bold and conclusive leadership of the president and his cabinet the question has been finally settled. The renewal of activity and energy can be witnessed throughout the country. Before the next congress assembles the favorable conditions of the country will forbid any further malignant influence on the part of the so-called silver States and their mis-representatives in the senate and house.

THE GROWTH OF AMERICAN EXPORT TRADE.

By T. A. Eddy and Carl Schurz.

Mr. Thomas A. Eddy, of the great New York exporting firm, Flint, Eddy & Co., sailed on May 4 for Europe, and thence to South America, for a long business trip, and, just before embarking, he was interviewed by a reporter for the New York *Sun* in relation to the outlook for American export trade. His information is of such definite character, and what he has to say is of such manifest importance, that in the interest of American industry and enterprise we reproduce those portions of the interview of special concern to our constituency of readers.—THE EDITOR.

AMERICA will probably, in the near future, dominate all the markets of the world in the production of manufactured goods. The old-time supremacy of England is on the wane, and even in England itself many grades of American goods, particularly cotton goods, manufactured leather, and iron, are sold more cheaply than the native products. Indeed, the United States are going into the manufacturing export business at a rate which is causing grave apprehension to English and other European manufactures.

Whereas at one time almost the sole export business of the country was in food and agricultural products, to-day the export of manufactured goods is about one-third of the total export of the country, and is annually growing at a rate which to foreign competitors is alarming. The age-honored theory that the markets of the world could never belong to America so long as American wages continued to be the highest has proved a fallacy. The industry and superior genius of the American workingmen, more than make up the difference in the wages.

The United States have need of this increase in the amount of manufactures exported to maintain in our favor the annual balance of trade, for the reason that our exports of food and other raw products must inevitably decline. Thus the new Argentine competition with the United States in wheat may be expected to increase permanently, lessening our hold upon the world's grain markets. It is true that there has not yet been so great an increase in the total value of manufactured goods exported, but it is estimated that of late the average decline in the price of the goods included under this head has been not less than 15 per cent., indicating a considerable increase in volume, although on a lower basis of value.

In certain classes of tools and hardware Americans, owing to the greater use of machinery and larger output, have long stood pre-eminent. Australian and South African doors are furnished with American locks and knobs, and we furnish the doors themselves. An infinite variety of hardware used in the construction of dwellings is also shipped abroad in great quantities, and some people may be surprised to know that one of the very best markets we have is England.

Of the new articles of export, take barb-wire fence. Five years ago the cheaper labor of England, Germany, and Belgium made it impossible for American manufacturers to compete with those countries in supplying this article. In these five years the superior genius and industry of the American workmen have revolutionized the business of manufacturing wire in this country, and enabled us to supply the whole world with it. We have beaten England, Germany, and Belgium in their own markets. We have driven their own manufacturers out of the export business. Take the next article that I mentioned,—wire nails. For years German and Belgian manufacturers have defied competition. They have undersold the Englishmen and have controlled the English market, but have learned how to make wire nails. Our inventors have given us machinery superior to any possessed in either Germany or Belgium, and wire nails are now being shipped from the United States to every part of the world in ever-increasing quantities. I know of one order for 20,000 kegs of these nails, given by one of the great houses of Birmingham. We landed those nails in England cheaper than they could be made there and cheaper than they could be imported from continental countries.

Now look at the steel business. We are to-day exporting American steel rails to Cuba in competition with German and English manufacturers, and our manufacturers are extending their inquiries for business to South American countries. In this commodity tonnage is the principal question. The more we make, the cheaper we can make. The more we increase our output, the more dangerous competitors we become to England and Germany. It is only a matter of time when we shall control a large portion of the markets of the world in this line. American locomotives have been shipped to Brazil, to Argentina, and even to Australia. We manufacture them here and ship them to those countries and deliver them to the purchaser there set up on the rails in running order, at prices very much lower than the English or continental manufacturers can name. Armor-plate is another thing that we have begun to export. You know, of course, that this is now being supplied by one of the great American iron works to the Russian government, the order having been taken in competition with the most celebrated English and European makers.

We are particularly successful in the exportation of agricultural implements, such as harvesters, mowers, and headers. We are shipping these articles in great quantities to Russia and to South America, and our orders are constantly increasing. It is only necessary, in order to demonstrate the fact that our great competitors, the British, fully appreciate the competition which this country is now giving them, to quote from an article in the London *Times*. I don't remember the exact date, but I made a memorandum of the words:

> Speaking at a meeting of the council of the London chamber of commerce last week, Mr. Bindloss made rather startling reference to the diversion of the British iron and steel trade to other countries. Of late years the United States had developed their own resources, and had so stimulated production that they could not only supply themselves, but severely interfere with England in foreign markets; and he would not be surprised if by and by they threatened competition even in this country.

The competition referred to by Mr. Bindloss has come to pass, as great quantities of American iron have been shipped to England itself, and contracts are made to-day by which American manufacturers undertake to lay down gas, steam, and water pipes in English warehouses at lower prices than the Englishmen can meet.

In the great gold and diamond mines of South Africa all of the iron pipe used is produced in America. Why, within a few weeks a single consignment of a train-load of twenty cars was shipped to Africa. Nearly all of the gold-mining machinery of the great mines of the Transvaal is made in Chicago, and not many months ago a steamer was loaded at New Orleans with machinery for Africa. It was shipped down the Mississippi river to that point. Take bar iron as another example; that is the iron for blacksmiths' use. We are shipping that to Japan and China and other Eastern countries. A very recent shipment consisted of 450 tons. We are shipping cotton ties and hoop iron to Bombay and Calcutta.

Sulphate of copper is another article which is very largely exported to France and Italy, and small shipments have been made to South Africa. Not only is the American sulphate of copper much cheaper than the European or English product, but it is of infinitely better quality, and promises to control the markets of the world.

There was another article in the London *Times* recently which pointed out that the United States had practically overtaken the United Kingdom as a coal-producing country. Just take the figures a moment. In 1870 the United States produced only one-third as much coal as Great Britain; at the end of the next eleven years—that is, in 1881—we find that the product had increased to one-half that of Great Britain. To-day the two countries have practically come abreast of each other, and the result has been that everywhere Great Britain has ceased to command the supremacy which she formerly enjoyed as the chief coal-

producing country of the world. I think it will be a matter of surprise to some people to know that regular shipments of coal in cargoes are made to Liverpool for gas-making purposes. The United States produce the finest coal in the world for making gas. The Englishmen have learned that, and they purchase it in preference to their own product. The Spanish and English West Indies are supplied with coal from the United States as far down as Grenada,—one of the most southerly of the Windward group of islands in the West Indies. The mineral statistics show that the average value of the coal output of the United Kingdom in 1892 was 7 shillings and 3 pence, and in 1894, 6 shillings and 9 pence, per ton. In the United States the reported value of the output of bituminous coal for several years past has not averaged much over 4 shillings and 3 pence per ton, and in some States the average has been about 3 shillings and 6 pence. Hundreds of cargoes of coal are ordered from England at prices considerably in excess of those at which the same coal could be bought in the United States, the main reason being the fact that with free trade they are able to secure lower freights for coal-bearing shipping, because such vessels can obtain return cargoes.

I was very much struck by an article that was published lately by Hiram Maxim. In that article he referred to the skill of American mechanics as compared with the English, French, and German, and he awards the palm to the Americans as being more intelligent, more industrious, and much more productive ; furthermore, as possessing the inestimable advantage of not being so seriously hampered by trades unions as is the case in England. That article was true. The American workman is also much more inventive than the workmen of any other country. Why, go into a factory to-day and you will see something being done by hand, and you go in the factory next week and you will find that some workman in the factory has invented a machine to do the work. The machinery in American factories is largely the invention of the American workman, and the improvements on the original machine are of his invention. He will go to work at his machine, and in a day or a week he will think of something that will make that work just a bit easier, or that will make it possible to run his machine at a higher speed, and to get more out of it. He will set himself to thinking, and shortly he has got an improvement that maybe doubles his producing capacity.

It is true, too, that the American workman is not seriously hampered by trades unions, as is the case in England. I know it is generally understood that the relations between capital and labor in this country are strained. The newspapers talk about it, and the Socialists and Anarchists talk about it, and the dissatisfied of the population lecture on it, and try

to drum it into the ears of their fellow-workmen, but the relations of the employer and employed here are infinitely better than they are in Great Britain. Why, here was a case not long ago in Fall River, where the manufacturers, without even a demand being made upon them, restored the rate of wages paid last August. They did this without anybody asking them to. If there had been any strained relations, it is not likely they would have done it.

England is actually cursed by trades unionism. A very good illustration of this fact is furnished by the shoe strike in England, where the prices to be paid to labor for shoe-making are established by trades unions. This strike was brought about by the desire of the English manufacturers to introduce improved American machinery in order to meet the American competition, and the workmen declined to use the new machinery and struck. You don't find the English workmen inventing machines to take the place of hand-work. They not only won't invent them, but won't permit their use when they are invented. Before this strike began the American shoe trade had for some time been rapidly increasing in England. As with other manufactured articles, the commodity, once introduced, took a firm hold. By striking, the workmen there have given the American manufacturer a golden opportunity, which he has seized. He was ready for the strike with a big stock of goods already there, and he has been shipping steadily ever since. Within the last six months the shipment of shoes to England from the United States has been large, and it is steadily growing. There is no reason why the United States could not hold that market. With their improved machinery and their superior industry they can undersell the natives.

Tool steel is one of the articles in which the United States stand preëminent. They produce the finest steel in the world, and at a price whereby American manufacturers are fully able to compete with the finest English and continental products, and they are doing it everywhere.

Dry goods may be considered a new class of exports, and a rapidly growing class.

American paper is cheaper than any other paper, and several of the London and Liverpool newspapers are printed on it. Nearly all Australian and many South American journals use it.

American moquette carpets are seriously challenging the English article, and are sold so cheaply in England as to have brought about a heavy reduction in the price of the English Axminsters. That trade is increasing rapidly, too.

A very much larger variety of all classes of merchandise might be exported, were it not for the discrimination in freights against Ameri-

can shipments. This is owing to the exclusion by our tariff of return cargo. The new tariff, however, has either reduced or removed the duty upon so many raw materials that, as soon as the manufacturers have fully equipped themselves to take advantage of the new order of things, this difficulty should be largely overcome. A careful study of the world's markets and a comparison of the prices of American manufactured goods with those of other countries make it clear that the door of our export trade is only ajar, but American enterprise and American intelligence and push will undoubtedly throw the portal wide open, and give to the United States the supremacy in the manufacture of nearly all classes of merchandise for shipment to non-manufacturing countries.

Confirming Mr. Eddy's statements, the following official records of exports of American manufactures is interesting :

	1873.	1884.	1894.
Agricultural implements	$ 2,585,916	$ 3,442,767	$ 5,027,915
Carriages and horse-cars	500,827	1,582,459	1,649,154
Railway cars	1,145,067	1,444,039	1,700,521
Clocks and watches	876,105	1,359,690	1,302,813
Coal and coke	2,914,075	5,051,509	12,093,474
Copper and manufactures thereof	259,076	5,595,859	22,132,856
Cotton manufactures	2,947,528	11,585,211	14,340,886
Flax, hemp, and jute	445,825	1,397,772	1,288,912
Gunpowder and explosives	3,092	1,177,922	1,002,126
India-rubber goods	214,798	635,046	1,461,842
Scientific instruments and apparatus (including electrical)	49,890	557,424	1,534,277
Iron and steel and manufactures thereof	11,323,919	21,901,962	29,220,224
Leather and manufactures thereof	5,305,494	8,090,029	14,283,429
Naval stores	3,809,431	3,119,200	6,790,948
Oil-cake and oil-cake meal	72,698	7,115,153	8,807,256
Oils—animal, mineral, and vegetable	44,153,674	50,126,188	47,756,684
Marble and stone	286,530	603,300	1,054,814
Paper and stationery	658,248	1,272,810	2,589,912
Soaps	667,858	740,426	1,139,722
Sugar and molasses	1,801,428	6,316,124	1,209,411
Tobacco—manufactured	2,642,811	2,530,457	3,849,996
Wood—manufactures of	3,189,445	5,349,720	6,773,724

At the 122d annual banquet of the New York chamber of commerce, among the notable after-dinner speeches was one by Mr. Carl Schurz, to whom had been assigned as a topic, "Foreign Commerce." Said he :

If we wish further to extend and develop our foreign commerce these things are necessary :

1. That we should have something to sell.

2. That we should adapt the goods we wish to sell to the requirements and tastes of those to whom we wish to sell them.

3. That we should be able to sell our goods as cheaply as goods of the same kind and quality are sold by other people in the same markets.

4. That, if we sell to foreign nations, we must be willing to buy from them, one-sided international trade being a contradiction in itself.

You will tell me that there is nothing new in this. Certainly there is not. It is an old story—as old as common sense. But it is amazing how far some people contrive to get away from such evident truths as soon as the practical application is called for.

Last year I was in Europe, and one day dined at the house of a prominent merchant in Hamburg. There were about twenty ladies and gentlemen at the table. The dinner talk brought me one surprise after another. It turned out that most of the ladies present—I think even all of them —had been across the seas, and spoke about Hong Kong, Shanghai, Bombay, Zanzibar, Mexico, Montevideo, Buenos Ayres, Rio, Valparaiso, Havana, etc., as familiarly as our ladies speak about Long Branch, Newport, or Bar Harbor. All these ladies had lived at such places with their husbands,—merchants who were still in business in foreign parts, or had been there in their younger days, either having establishments of their own or acting for German houses, but in either case studying the habits and tastes of foreign peoples and the requirements of foreign markets as well as the export resources of foreign countries, and giving the commerce of their German home the benefit of their studies and experiences. The company I met was, as I was informed, by no means an exceptional one. It rather represented the rule among that class of business men, whose education is scarcely considered complete without the foreign course.

Do you not think that, when we hear of German commerce crowding out that of other nations in many parts of the world, this fact may in some measure be owing to the systematic care with which the study of foreign markets is cultivated? Now, if our young merchants, married or unmarried, devoted a little less time to Fifth avenue, Newport, and Paris, and a little more to Buenos Ayres, Rio, Valparaiso, Shanghai, Zanzibar, and similar places, thus enlarging their mercantile education too, would not that be likely to do our foreign commerce a world of good?

I do not intend to discuss the general question whether our high protective system is, on the whole, a good or a bad policy for the country, but only the narrower question of the relation existing be-

tween the tariff and our foreign commerce. And then I say that, as the tariff enhances the prices of the things the manufacturer has to use in the production of his finished article, it enhances the cost of production ; and, as it enhances the cost of production, it enhances the price the manufacturer must ask for his finished product to make a reasonable profit ; and, as it enhances the selling price of the manufactured goods, it puts them at a disadvantage in the foreign market, renders them unfit for exportation, and thus narrows and cripples our foreign commerce.

The remedy naturally suggests itself. It consists in such a revision of the tariff as will deliver our manufacturing industries of those artificial burdens which increase the cost of the things they have to use in production, thus permitting them to obtain those things as cheaply and advantageously as their foreign competitors obtain them, and in that way giving them a fair chance for the export trade.

We have heard strange doctrines—ancient superstitions revived—in our days : that commercial intercourse with foreign nations is a thing of doubtful desirability ; that importing is sinful ; that goods may go out of the country, but only cash should come in ; that, when an American merchant sends a ship to a European port with a cargo that cost here $100,000, and he sells that cargo in Europe at a profit enabling him to buy a cargo there costing $125,000, and he ships that cargo to South American ports and sells it again at a profit enabling him to buy $150,000 worth of hides and other merchandise to be brought to New York, the balance of trade will be against us $50,000, and the United States have lost that amount. I think the barbarous doctrines I have mentioned do not deserve another word. Let them stew and smother in the depth of their own absurdity.

IRRIGATION SURVEYING IN CALIFORNIA.

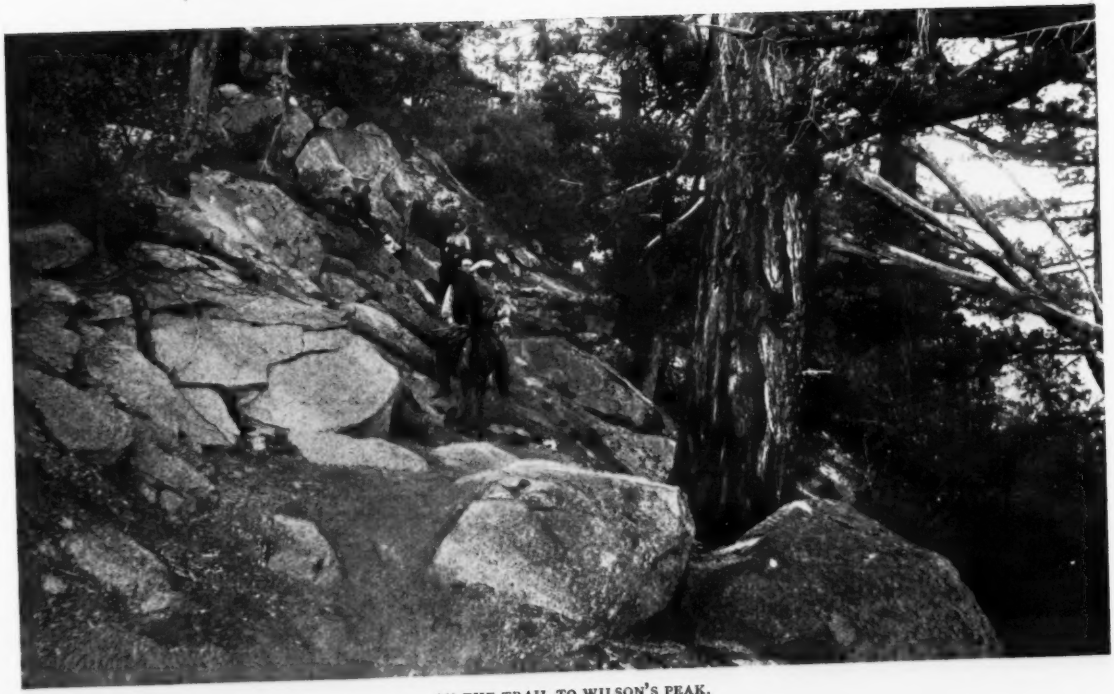
By Charles Evan Fowler.

FROM a point of vantage between Los Angeles and Redondo by the ocean can be seen in the spring a sight of grandeur long to be remembered. To the southeast, after a stormy period in the mountains, a peak of the Sierra Madres, 40 or 50 miles away, upholds a cap of snow; more to the eastward San Jacinto, the most beautiful peak in Southern California, rises snow-capped to more than 10,000 ft. above sea level, fully 100 miles distant; San Bernardino, the peak which is the basis of all the land surveys, stands, shimmering-white, 85 miles away, rising to an elevation of over 12,000 ft., in a ridge renowned as Grayback; San Antonio, or Old Baldy, in plainest view, yet 50 miles away to the northwest, has an elevation of over 10,000 ft., and is the highest peak of the snow-capped range to the north, which in supreme beauty upholds such a bounteous supply of moisture for the thirsty lands below.

These mountains hold the snow for some months, and in some of the cañons at a high elevation snow can be found all the year through. The melted snows find their way down the cañons in cold, sparkling streams, which must be conveyed to the desert or dry lands in the valleys to make of them the fruitful orchards or vineyards. Away up at the headwaters these cañons are narrow and rocky, in some places not more than a gorge, whose upright walls reach high above and confine the waters as they rush down the steep grades in tumbling cascades or break in snowy whiteness over a sudden drop of 50 ft. or more. They widen out lower down to hundreds of feet, or to a half mile or more, and in times of flood almost uncontrollable torrents roar down, filling the cañons from side to side, carrying along huge boulders of many tons' weight over a bed of rock *débris*. During the summer months, and until late in the fall, the streams of from a few hundred to thousands of miners' inches' capacity sink in these beds and flow underground, perhaps not appearing again, or coming to the surface as springs below, to form new streams.

It is during these months of quiet that surveys must be pushed and work prosecuted, with the object of making these waters available for irrigation. Nearly all those which were easy to conduct by comparatively inexpensive works have been taken up by the colonists and companies; so that, for new supplies, search must be made at some distance into the mountains, and means devised to convey what has been considered inaccessible.

YUCCA PALM, NATIVE OF THE DESERT.



ON THE TRAIL TO WILSON'S PEAK.

The engineer in charge of irrigation work must start out in an almost unknown region, equipped with an aneroid barometer, hand-level, pocket compass, and a supply of provisions sufficient to last during the trip, to search for streams of such volume as will justify the investment for dams, reservoirs, tunnels, and canals. Barometer readings are made to determine whether or not the water can be taken from the streams at an elevation high enough to enable it to reach the lands as desired, and to ascertain the feasibility of tunnels of reasonable length. The distances have to be estimated, and to do this with any degree of accuracy requires long familiarity with mountains; but the barometer readings prove very accurate in such a climate, and are great aids to the surveys which follow.

Many companies, as is true elsewhere, wish to obtain quick returns from their investments, and spend but a short time in such *reconnaissance*.

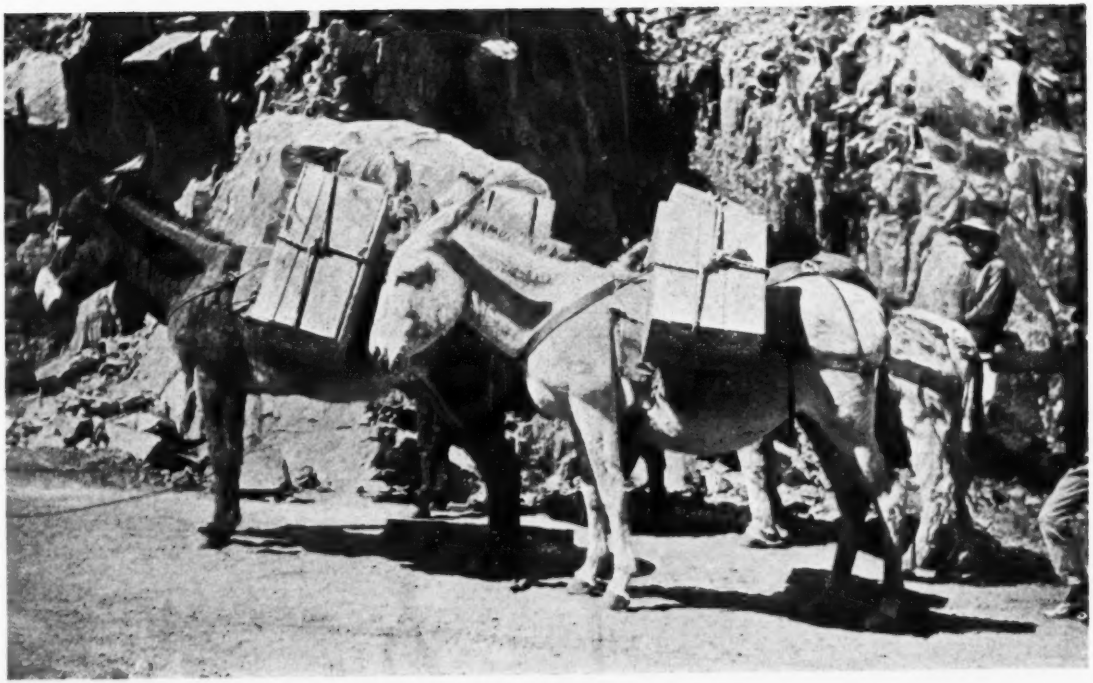
The beginning of an extensive survey of a thorough character was made toward the last of March, 1891, by the selection of Banning in the San Gorgonio Pass on the Sierre Madre mountains as headquarters. The country to be surveyed and examined was tributary to "Old Grayback," and comprised some 250 miles to the southeast.

Township plats were secured from the United States land office to use as data in compiling a map of the region; but the section lines had been run by the old surveyors only up to the foot hills, and beyond this were legends—"Rocky, precipitous mountains," "Mountains densely covered with chaparral," "Unsurveyable"—in lieu of the information wanted. Where the lines had been run, out in the open country, distances and bearings were given, and old roads, Indian trails, and washes were shown, many of which had been obliterated or changed long before.

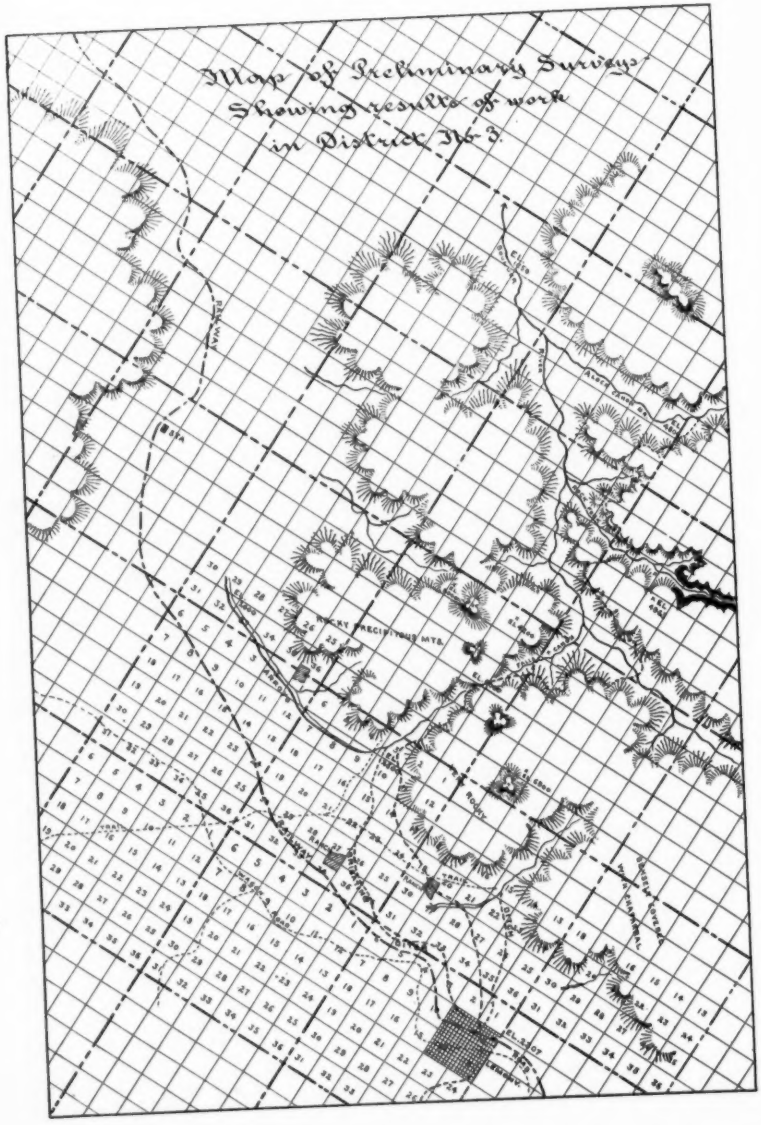
It was imperative that no time should be lost while the dry season lasted; so, while waiting for an office outfit to arrive, a map was begun on a scale of 1000 ft. to the inch, in a manner to cover, as nearly as possible, all the country to be surveyed.

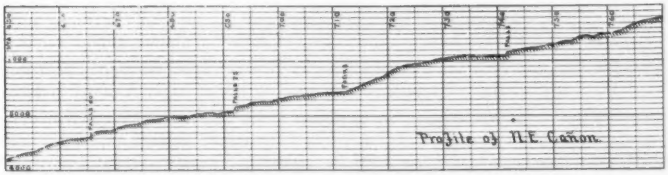
Field work was soon begun by running a preliminary line to connect the future surveys with established land lines. The corps consisted of both transit and level parties. Nearly all wore the wide Mexican sombrero, and high lace boots as a protection from buckthorn, cactus, and rattlesnakes; and, as some of the corps sported knickerbockers, the crowd made a picturesque appearance.

The instruments were a light mountain transit, steel tapes and plumb bobs, flat sight-poles 10 ft. long with plumbed centre lines, hand-levels, a hand-axe with scabbard for each person, and a supply of stakes. The level party used a short Y level. As the corps was away



THE BURRO EXPRESS.


Map of Preliminary Surveys
Showing results of work
in District No 3.

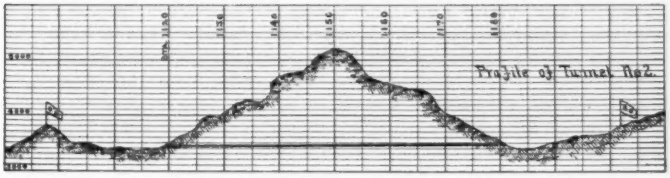


from the streams part of the time, each person carried a canteen, while a large metal lunch-bucket, well filled, was always in charge of the flagman. The transit lines were run up many of the cañons, to be utilized later as connections from the other side of the range. Many of these were nameless; one, having a bee ranch, was put on the map as Bee Cañon, and another, which boasted a stream of water in summer, we called Water Cañon. Level lines were also run and benches established at convenient points, with sea level as datum.

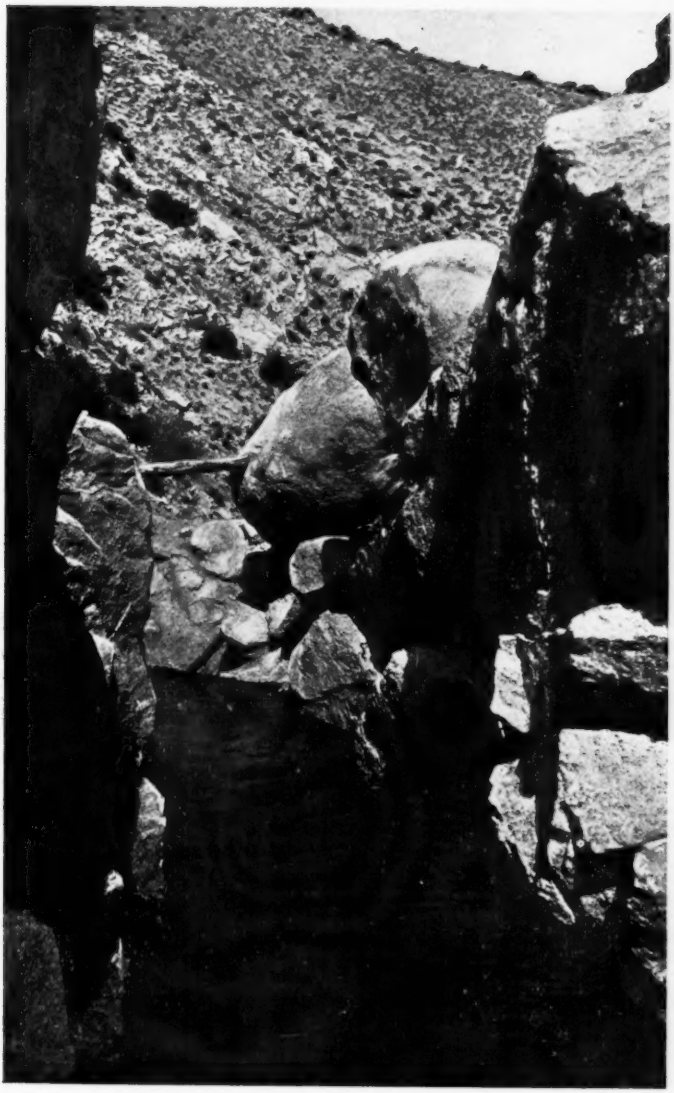
Nothing unusual was encountered in the Pass except the low chaparral, sage brush, and cactus, which were not high enough to interfere with sights and chaining, although, while one was trying to avoid some cactus, a bunch of "Cat claws" would claim attention.

Long sights could be taken in such a clear atmosphere as the eastern slope of the San Gorgonio Pass, and the chainmen were often allowed to go a half a mile ahead before making a new transit point, and on a very clear day sights of 3000 ft. could be lined in with ease. Five or six miles were made in a day, when station stakes were to be set, besides a long drive through the sand to and from work.

Orders were soon received to push work into the mountains, where short sights were the rule,—often, in the narrow crooked cañons only 30 or 40 ft. The work frequently became so slow that it was necessary to make a triangulation for some miles. The topography was sketched in, and points were located by separate intersections when desired. By this time surveys had been carried so far from Banning as to necessitate the pitching of camp nearer to the work. Tents, provisions, and supplies of all kinds were hauled by desert wagons 10 or 12 miles east to White Water Ranch, which was near the mouth of White Water Cañon, and then carried by burro train 13 miles up the



FALLS AT HEAD OF WATER SUPPLY IN SIERRA MADRE.



GRANITE WALL OF HESPERIA CANAL—THE DEEP CUT.

COMMISSARY DEPARTMENT OF CAMP.

cañon to the site selected for camp. The burro train, of eighteen or twenty animals, was kept busy for days, filing up and down the cañon with huge loads cinched on for the up trip of the "sober burro."

While this was in progress, a transit line was taken up and extended by the main cañon. The first day's work was on the edge of the desert, where the heat was so intense that our supply of water soon gave out, and the back flagman was loaded up with canteens and sent to the foot-hills for a fresh supply. How thirsty a person can get while compelled to wait for a drink, in plain view of snow-clad peaks, is never realized until tried. Hard work found us at night near the old adobe or "doby" ranch house at White Water; and, after a wash in the irrigating ditch, and a supper cooked and eaten under the cottonwood trees, we all turned in.

San Jacinto's snow-white peak was glistening in the sun, over 8000 ft. above us, as the breakfast was being cooked and eaten for an early start the next morning.

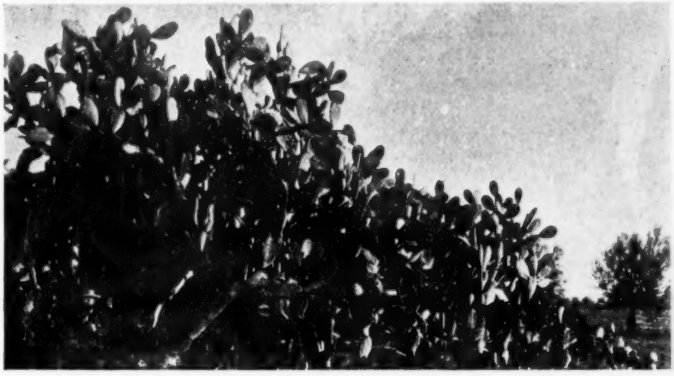
It was the expectation by this early start to reach a half-way camp up the cañon that night, and we soon came into sight of the huge brown buttes near it, only to learn how deceptive distances appear in such a climate. Evening came after a hard day's work, and the buttes apparently as far away as ever.

Next day we were between half-way camp and Red Rock Point, a conspicuous hump of red paint rock, in the midst of the great white "wash" nearly 2000 ft. wide. Permanent camp was reached about ten o'clock the next night, after stumbling by moonlight over several miles of the rocky wash; and Sam Lee, the Chinese cook, was called out of bed to get up a supper.

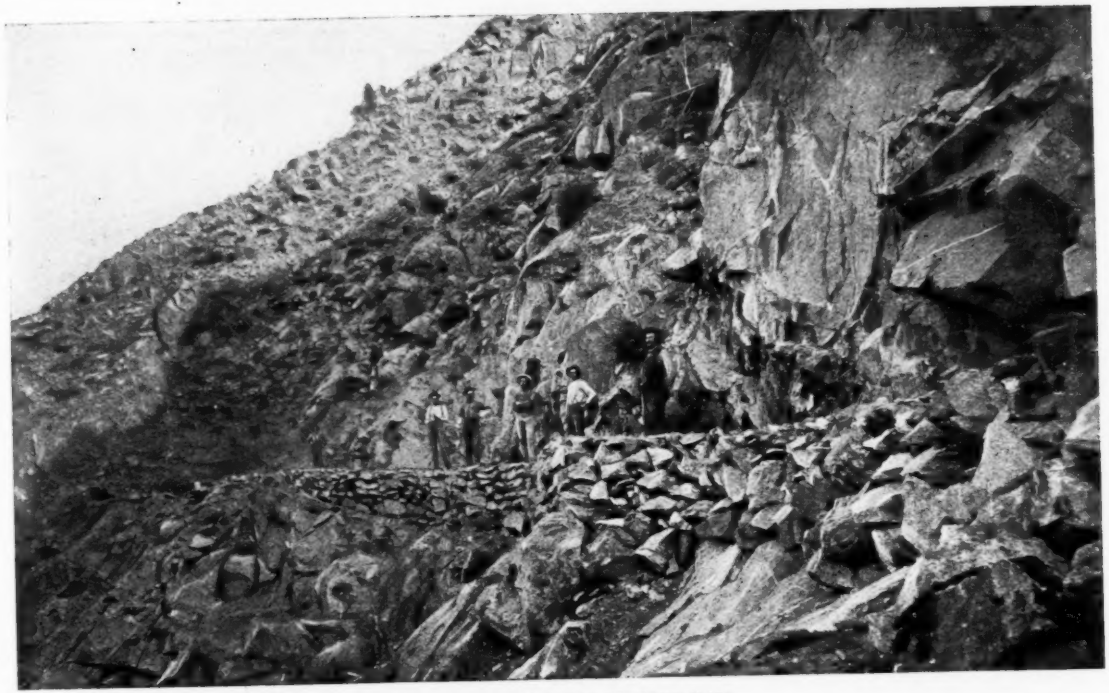
The camp consisted of a cook-tent with small stove, a store-tent, and a dining-tent with a table made of short redwood boards nailed across two poles. Besides these, there were four sleeping-tents, which soon boasted of pole cots with pine-bough mattresses.

From this camp transit and level lines were run 6 or 7 miles in the main cañons to map all of the country, and the notes were worked up and plotted when occasion offered. For some weeks not a glimpse was had of civilization. Mail and fresh meat came once a week by "burro express" from Banning, about 25 miles *via* the cañon.

The principal streams had been located, lines of level run up them, and the outlines of the cañons sketched in; and we were ready to begin lines up those which had been selected as possible routes for tunnel location. Some of those which proved best had but little to show for it,—narrow rocky openings, winding about, so that very short sights had to be taken, and often requiring more time than some of our longest sights out in the more open country. Frequent waterfalls were encountered, often from 30 to 50 ft. high, and were a source of much delay. Once the only way to carry up our line was to mark a transit point on the rock at the very edge of the falls, over which little water was running at the time, pass up the transit by forming in line, and, after scrambling to the top by holding on to the bushes, to discard a



A HARD BIT OF CLEARING.



ON THE HESPERIA CANAL, SHOWING WALL.

HESPERIA DITCH LINE.

slippery pair of boots and in stocking-feet venture to set up the instrument over the point,—no joking matter.

In some cañons where there was much water a dense growth of bushes and trees had to be cut out, and, as the summit was approached, big spruce and pine from 2 to 5 ft. in diameter were plenty. A profile of such a cañon is shown. On reaching the end at a saddle in the divide, 5000 or 6000 ft. above sea level, grand views were had of the country for nearly 100 miles away across the pass towards the Pacific ocean, and on very clear days the ocean itself could be seen. The view did not seem real, but more like a great relief map, white washes or beds of streams winding about, the rolls and hollows looking like huge wrinkles, while here and there black spots marked the dark green acres of orchard. On cloudy days, at this elevation, one would be in the midst of clouds, and have to stand at the transit by the hour for an occasional glimpse. Or, when the clouds were below, looking like a great ocean, the country, seen through occasional breaks, appeared to be hung in mid-air.

The whole southern slopes of the mountain were dark green or almost black in a velvety coat of chaparral from 2 to 10 ft. high,—scrub oaks almost as hard as iron-wood to chop; thousands of acres of manzanita, with its beautiful red bark, and crooked branches carrying leaves somewhat like mistletoe and, later, a crab-apple-like berry; mountain mahogany, greasewood, chemise, and, to the disgust of the axemen, great quantities of buck-thorn that seemed to resist every effort to reach the main stem, which cut like cheese.

Starting down a cañon from the saddle, we had our first experience with this chaparral while all the axes were sharp. The manzanita was most easily broken or tramped off, as it was very brittle; but by the time we were ready to quit in the afternoon the oaks had not left much edge to the axes, and, with every man chopping hard, the transit book rarely showed a progress of more than 1000 to 1300 ft. in a day. When only running lines through it for closure of surveys or for a connection, stadia readings were taken of from 800 to 1000 ft. from ridge to ridge over it all, although much time was still consumed in forcing our way through it, as often it was so dense that one could walk or scramble over the tops. The bottom of the cañon once reached, and our way cut through the willows, sycamores, and alders along the streams, then a long, weary tramp had to be taken, 4 or 5 miles back over the range, to supper at camp. When this became too tiresome and time-consuming, canned goods would be packed up with ten or twelve loaves of bread and a supply of crackers, blankets rolled up, and all, including cooking utensils, cinched up tight on our camp burros and put in charge of the Mexican driver, who was ordered to follow us up or make

CHAPARRAL.

VIEW ON MOUNTAIN SIDE AHEAD OF SURVEY LINE.

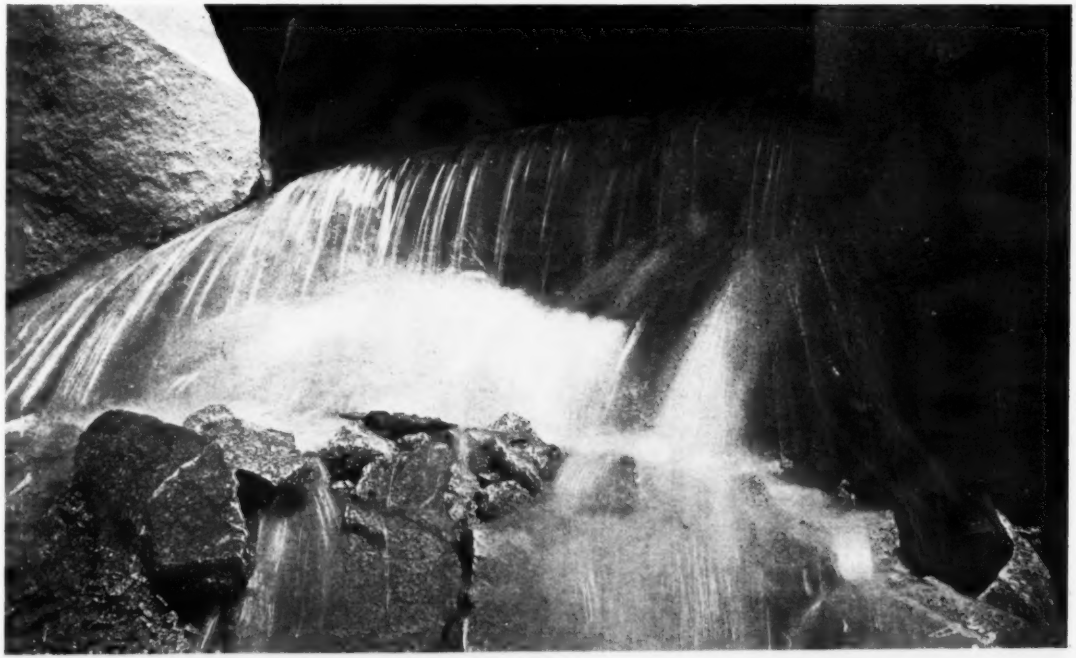
a point ahead of our work. And then every night, until provisions gave out, camp would be made where work was left off. Rolled up in a blanket on the sand, with sky and stars above and a balmy air to breathe, one could have a royal sleep.

When all these preliminaries had been completed, our original map was filled to about the extent shown in the accompanying one, which is the best that can be given from the topography "sketched in" on a preliminary survey.

When, in addition to this, level lines had been located up the desired streams and cañons far enough above the lands to which the water was to be carried to allow for the necessary fall in the estimated distances, the preliminary location began. The elevations were decided

MOUNT DIFFICULTY AND MOUNT DISAPPOINTMENT FROM WILSON'S PEAK.

A MOUNTAIN WASH IN SUMMER.



OVERFLOW FROM WATER GATE IN THE TUNNEL.

upon for the main tunnels, the probable lengths were scaled from the map with gradients which ranged from one in four hundred to one in one hundred, owing to the different materials to be tunneled; the elevations of the ends were fixed; and contours were run in the field to arrive at the very shortest distances.

In running tunnel lines straight over the mountains, with no chance to avoid big trees or cliffs, great pines had to be chopped, the axeman often having a very slight footing; and, when the trees fell, they would go crashing down the mountain-side, carrying tons of rock from the cliff, making a grand sight. Clearing over the cliffs was at times very dangerous and almost impossible.

When all the line was cleared, two parties of chainmen would be put to chaining the line with steel tapes, hand-levels, and plumb bobs. Center lines were also re-run with the field instrument, and back-sights set for use in case the location was adopted.

From these established tunnel portals grade lines were then run around the mountain sides, with assumed gradients and estimated distances, up to the points from which water was to be taken from the streams, and, on the other side, down to the point of delivery. When the grade line is finally established, then begins the final location, which is similar in a general way to that of a railway. Grade and slope stakes are set for cuts and fills, or for canal excavation, and profiles are made of cañons to be crossed, either by high flumes or bridges.

The grades are generally made as steep as possible without causing wash in the channels, and, in rock or cement ditches, range from a few feet up to (occasionally) several hundred feet per mile. The tunnels, when driven in rock, present a very rough surface to the running water, and in a year or two, when it has become necessary to increase their capacity, they are made smaller by a cement lining,—the smoother surfaces allowing a much greater flow in a smaller channel.

Many examples might be given of the canals which have been built around the steep mountain sides; of high flumes over deep cañons, such as can be seen on the San Diego Flume Company's line; of hanging flumes on precipitous cañon walls, like those in Colorado; and of the many trails and expensive mountain-roads which have been built as accessory to such irrigating canals in seemingly inaccessible mountains. But the reader has doubtless gained some ideas of the difficult work which has made and is making Southern California a great semi-tropic garden.

Irrigation is destined, however, to have a large share in the development, not only of Southern California, but of the millions of acres of arid lands in other western States. It is estimated that from two-

VIEW NEAR HESPERIA.

WEST FORK OF THE CREEK.

fifths to one half of the North American continent is arid or desert land, and of the United States nearly all lying west of the one-hundredth degree of longitude is arid or semi-arid. This great domain embraces about 960,000,000 acres, of which only a portion is arable land, and of this there are probably about 20,000,000 acres under ditch or being irrigated. Probably 25 per cent. more of this is arable land, or enough to make homes for millions of people, if water can be conserved and developed in quantities sufficient to serve some of the large tracts not now under ditch.

The number of acres which can be irrigated by a given amount of water varies greatly, being much greater for old land than for new and depending largely on the character of the soil, as well as the appliances and skill of the irrigators. The unit of measure, which is the second-foot or 1 cu. ft. per second, is made to serve in some places only 70 or 80 acres ; but, where more care is used, this duty can be increased to many hundred acres, and in some cases it is claimed to reach nearly 1000 acres by piping the water directly to the point of use.

The primitive method was, and in many instances still is, to divert the water from the stream by an earth-ditch or canal, from a few to many feet in width, to distribute it by lesser ditches or laterals to the highest corner of each field or tract, and to further distribute it by ploughed furrows or lesser laterals to each tree or every portion of a field. This necessarily made a maximum loss from seepage and evaporation, and was very wasteful.

This was then improved upon by substituting cement ditches or wooden flumes for all except the lesser laterals or furrows, thus in great measure doing away with loss from seepage and increasing many fold the duty per second-foot. Still further improvements have been projected by all the older companies, in order to pipe the water directly to the point of application, and thus save nearly all the loss from both sources and increase the duty to about ten times that of primitive methods.

Not only to this source can we look for a large increase in the number of acres under irrigation, but to the great storage-works constantly being projected and constructed, which will store during the wet season millions of gallons of water that would otherwise rush down to the ocean,—a complete loss and constant menace to the horticulturist. These storage-works will develop very slowly, however, owing to the fact that the value of the property which must bear the expense of construction amounts on the average to only about one-hundredth of the valuation of city property using the same amount of water.

Near Riverside, 20 years ago or less, the land was worth scarcely

$1.00 per acre, but now improved land is valued at from $1000 to $1500 per acre, while the unimproved land which can be reached by water is worth from $100 to $300 per acre.

This is not true of all sections, but it is true of many places; and, while fabulous tales are told of the production, it is safe to say that a tract of from 5 to 10 acres in fruit will support the average family, and in good years leave much to spare.

The ordinary potato has in many cases netted $100 per acre; alfalfa, which is used for hay, gives from four to eight crops a year, and nets from $75 to $100 per acre per year; muscat or raisin grapes net from $150 to $300 per acre: peaches, apricots, pears, apples, and other deciduous fruits, from $100 to $400: English walnuts upwards of $250: while the citrous fruits, which require about 6 years to reach the bearing point, attain much higher figures. In the case of navel oranges the net return is from $800 to $1000 per acre. These figures have been carefully collected, and are thought to be fair averages, although much higher ones have in many cases been reported.

As new reservoirs and canals are completed, constant opportunities are presented for the settlers to avail themselves of good locations, and it will be many years before the bright possibilities of the region are exhausted. The hopeful signs are the better forms of construction being undertaken and the great interest being manifested in the meetings and conventions each year which have for their object the furtherance of legislation in the aid of irrigation and irrigation works. as well as the exchange of methods and measures.

Indeed, it is not beyond the possibilities that this interest may spread far east of the one-hundredth meridian, and, in some future years of drouth, the farmer in the eastern and central States may have arrangements for the irrigation of his crops and orchards.

THE IDEAL CITY-ENGINEERING BUREAU.

By Francis Collingwood.

ONE of the most marked characteristics of the development of modern civilization is the ever-increasing diversity in all affairs, whether in business, science, art, literature, or the art of living. There is a constant differentiation going on, and a closer attention to detail, all leading to new occupations, new discoveries, and greater responsibilities on the part of the men who are now doing the world's work.

With this development, there is also a growing complexity, and an interweaving of interests such as the world has never before seen. This interdependence becomes most manifest in cities, and the more so as these increase in size.

The recent utter derangement of the business of a large city by a strike on the electric tramways is a case in point. The serious troubles arising from a break in a water or gas main, or a temporary stoppage in the supply of food or fuel, may also be cited.

Now, while it cannot be denied that among the ancients there were often men of great practical skill, yet the engineer as he now exists is a modern production, made necessary by the development of which we have been speaking, and by his own exertions and accomplishments hastening that development on its practical side at a speed far beyond what it has ever before attained. It does not detract from the honor due to the sagacious business men of our country to say that, while without *money* no great constructive enterprise can be carried through, neither can success be most effectively realized without the boldness and skill of the engineer.

The first point, therefore, to be made is that, no matter how small the community, it will always pay to place work of a public character in the hands of an engineer. The ideal scheme for the development of any town or city would be that the original location and lay-out of all streets and the location and design of all other public improvements should be scientifically done, and the results properly recorded ; and that all additions should be similarly treated. The ultimate saving in time, money, law-suits, and comfort would be immense.

To reach anything like this state of things will require a long educational campaign, and, while not impossible of accomplishment, it seems almost hopeless at the present. In a town of 5000 to 10,000 inhabitants a street commissioner is usually appointed because he

knows how to "turnpike" a road. When an engineer is called in, he finds buildings and sidewalks arranged without regard to grades, and what grades there are not adapted to the ground or to any possible system. He finds street lines unmarked and none of them straight. If there are any records, he finds the maps incorrect. Should he propose to do the work necessary to correct this state of things, the money question comes in at once, and, in addition, the opposition of all those who oppose change, or imagine it might affect their property in any way.

As time goes on, the questions of water-works and sewerage become prominent, and it is exceedingly important that from the beginning complete records be made of the exact character, location, depth, and size of all pipes and sewers, and of the description of other constructions. The engineer should be adequately paid for doing the work, and the field-books, properly indexed, should be the property of the municipality. Much trouble has arisen from lack of attention to this requirement.

The difficulties arising from inaccurate surveys and mapping and incongruous arrangement of streets have led in several cities to the organization of a so-called Platting Commission, whose duty it is to examine all proposed additions to the city, as well as all rearrangements or subdivisions of territory, and to see that the streets are suitably laid out with reference to the topography and existing streets, are of the proper width, and are properly marked by permanent monuments. The city engineer is always a member of these commissions, and makes the necessary surveys and examinations.

In recent years other duties have been placed upon the engineering department,—such as the care of bridges and harbors, city property, parks, and buildings. This great range of work has led in the larger cities to the introduction of boards of public works. In most cases these are appointed by the mayor, either with or without confirmation by the council. These boards consist usually of four members, sometimes with the city or chief engineer as the fifth, acting as president. The city engineer is in some cases elected by the board, in some appointed by the mayor, and in some elected by the people. A very apt remark has been quoted in this connection: "Where you want skill, you must appoint; where you want representation, elect." There can be no doubt that permanency in the office of engineer is greatly to be desired, and the appointment should be as far removed from politics as possible. The more intimate his acquaintance with all the elements affecting his work, the more valuable will his services be; and the more free he is from political interference, the more economically can he do his work. The appointment by the board of

works would seem, therefore, to be a wise provision, and it has produced good results where it has been the rule.

Where boards are thus formed, the commissioners are not all engineers, although this would be preferable. It is customary for each to take charge of one portion of the work, the president supervising all, but having only advisory powers.

A classification of the duties that may fall upon a city engineer at the present time would be somewhat as follows:

1. Surveys,—maps and other records;
2. Profiles, grades, specifications, estimates, and assessment maps for street-grading and paving;
3. Lines, grades, specifications, estimates, assessments for sidewalk-grading, paving, and curbing;
4. Sewer construction and maintenance, including all estimates, records, and assessment;
5. Water-works construction and maintenance, including all estimates, records, and, in some cases, assessments;
6. Bridge construction and maintenance;
7. Park construction;
8. Harbor and wharf construction and maintenance;
9. Street-lighting;
10. Street-sprinkling;
11. Inspection of buildings;
12. Regulation and improvement of streams;
13. Inspection of work done by various corporations,—gas, electric, &c.,—in so far as they are under municipal control.

In a *small* town these duties are comparatively simple. All work can be done by the engineer and one or more assistants; and, if careful records are made and so filed and indexed as to be readily accessible, nothing more can be desired. The difficulties arise when, through increase in population and territory to be cared for, the work becomes so extensive as to require separate departments for its prosecution; and it is here that widely-divergent systems have been adopted. Yet, while the interests to be conserved are very diverse, the city itself is a unit, and no mistake can be made in so concentrating responsibility and maintaining a thorough subordination of each special department as to secure the harmonious working of all.

An examination of the list of duties just given shows that they can be best fulfilled by engineers; as trained judgment and skill are especially needed in the economical prosecution of all public works. This being true, if there be a board of public works, it should consist of engineers, each at the head of a department, with the city engineer at the head of all as the executive. To each department

should be assigned the details of all field-work and the preparation of designs, specifications, and contracts in its branch of work, the construction and inspection of work, and the making of estimates and all maps and drawings for record,—all to be subject to the inspection and endorsement of the city engineer. The latter should be free from all routine matters, to give him time for the study of preliminary designs and such general examinations as would enable him to wisely administer his office.

It is questionable, however, whether a board of works of this kind may not be better styled the engineering department. In the former case it has been usual for the mayor to appoint all the members; but, if a thoroughly good man be appointed as city engineer, he may well be empowered to appoint the engineering heads of departments, subject to removal for cause.

The chief should be appointed by the mayor, and the term of service should be either during "good behavior," or at least long enough to make it worth while for a good engineer to accept the office.

The organization here sketched is in some respects a radical departure from what now exists, but it is based upon sound principles. The city government having decided that certain work shall be done, the subsequent steps of preparing, contracting for, and inspecting the work, or its execution by the force under the control of the appropriate department, become a matter of business, and political considerations should have no weight. A rigid system of accounting must be instituted, but that should be a part of any system. The heads of departments being chosen with especial regard to their fitness for the work in hand, true economy would indicate that all repairs and maintenance might be entrusted to them.

The number of departments to be organized in any case will depend on the size of the place to be served. The first division caused by the growth of a city would probably be into (1) surveys, park work, streets and sidewalks and everything appertaining to them; (2) sewers and water-works, street-sprinkling and lighting, and the regulation of streams; (3) bridges and inspection of buildings; (4) harbor work, if much of it be required.

The special surroundings of each city will indicate best how the division shall be made. As growth continues, subdivisions of these will be made, but nothing should be allowed to interfere with unity of design and management.

One of the most important matters to be arranged has not yet been considered,—*viz.*, the keeping of records, especially of the maps and drawings which accumulate so rapidly. For convenience in the drawing-room, it is almost a matter of necessity that complete

copies of all maps and drawings originating in a department shall be at once accessible. It is also true that in a large city the same drawing will be often wanted for reference by some other department, or by a citizen. This will be particularly true of property or assessment maps.

A record division is therefore essential; and, since the duplication of drawings is now so easily accomplished, it would seem desirable that the records should contain the certified originals of drawings, &c., from all departments, copies being made for use in the offices.

As to the exact method of preserving drawings, there is no agreement among engineers. The first requirement is that as far as possible a few standard sizes only be made. It is found that these are best preserved in shallow drawers with trays 1″ to 1½″ deep. Each drawer must be numbered, and each drawing contain the date of entry and the numbers of the drawing, of the drawer, and of the office or department in which it originates. The card system of indexing, where it has been tried, has been much commended, as it enables the recorder to make constant additions without disturbing the general arrangement.

The drawing should be entered on the index under every head which may serve to identify it. No drawing should be taken from its place without a receipt from the person removing it, and the originals of important drawings should never be removed from the office. The person in charge should be obliged to carefully examine and put in place all drawings, as far as possible, at the end of each day's work.

The general question here under discussion is a very large and important one. Towns and cities are the places where a considerable part of the population of a country must live, and everything done by the municipal authorities comes home to a large number of people. If an improper grade be established, some one may have a puddle in front of his door or possibly a flooded street under certain conditions. If a poor pavement be laid, it becomes a plague and annoyance to many. If a sewer be too small or badly constructed, stoppage, resulting in danger to health, may ensue. And so on, to the end of the long list of annoyances, great and small, resulting from poorly-designed or poorly-executed work. Again, if wasteful or dishonest methods be employed, or if political considerations rule in the employment of men, every man's taxes are increased, and living is made unnecessarily expensive. The scheme proposed may be utopian, but the "*ideal*" bureau only is under consideration. The more nearly this can be attained unto, the less burdensome and the more effective will be the result of its operations.

THE PROBLEM OF PURE WATER-SUPPLIES.

By Rudolph Hering.

IN a previous number of this magazine, under the heading "Sewers and Sewage Disposal," it was said that works for the supply of copious quantities of pure water for domestic and public purposes, and those for the subsequent removal of the same as sewage, held a rank second to none in influencing the health, comfort, and safety of the inhabitants of a city. For reasons then given, the removal of the sewage received the first attention, and it now remains to record the essential requirements for a supply of pure water for a community.

It should be repeated here that the recent progress of sanitary science has been such as to reveal, not only the causes of many infectious diseases, but also the means of prevention. Water-supplies polluted with germs of a specific disease have directly caused the propagation of that disease in a clearly traceable manner, while other supplies not thus polluted have protected the users from injury. Greater attention, therefore, is now bestowed upon the selection of a good water-supply, and upon the purification of any water which is liable to become polluted. The responsibility of city officials for neglect to furnish wholesome water can no longer be evaded.

Often enterprising individuals or firms gratuitously offer to the city authorities one or more schemes by which they will furnish "the best" water and in "sufficient quantities." Such parties avowedly desire to make money by their propositions, and unfortunately we sometimes find that this desire obscures the consideration of the health and comfort of the people. But, whether the works are to be built and controlled by private parties or by the city itself, it is the prime duty of the council to see that the water to be furnished will really be of sufficient quantity and of proper quality.

The quantity needed depends on the character of the population and on the uses to which the water is to be put. It varies in different cities from about 25 to over 200 gallons per head per day, where water is liberally used for manufacturing purposes, for elevators, and for public fountains, etc., and where there is little restraint either as to its use or waste. In Allegheny, Pa., the consumption is over 200 gallons per head per day; in Buffalo it is 193 gallons; in Washington, 160 gallons; whereas in Fall River it is stated to be 29, in Atlanta 36, and in Providence 48 gallons.

In a growing community provision should be made for a future population; but it is often a very interesting question to decide how

far into the future our considerations should extend. On one side we see the loss of the interest on that part of the investment which for a time does not bring a return ; and, on the other, we see the fact that, when an additional supply shall become necessary, it will then cost more to provide the means of securing it, owing to increased valuation of property and of water rights, than it would have cost to provide them in advance. This matter should receive careful attention.

All running water, be it in springs or rivers, has its source in the rain-fall. Springs that are nearly constant in their flow throughout the year, or rivers whose summer flow is greater than the quantity of water to be withdrawn, do not require a consideration of the rain-fall, when planning to supply a community. In other cases it is all-important, because it is necessary to store in ponds or reservoirs some or all of the rain falling during the winter and spring months, in order that it can be drawn for use during the summer months, when the natural flow of the streams is insufficient. It is frequently necessary to determine with great care the least rain-fall in the locality, both for a whole month and for the dry months, because a water-supply must be measured by the quantity of water available during the dryest seasons, just as the strength of a chain is measured by that of its weakest link.

Sometimes these problems are not easy to solve, particularly where storage is made difficult by the topography of the country. Small streams with an insufficient flow in summer have been utilized in a very satisfactory manner by providing storage facilities. Where it is practicable to build dams which can hold back many millions of gallons of water, we have been able to count on from one-eighth to one-third of the mean annual rainfall as collectible. The rest is lost.

There are some localities where natural storage-reservoirs exist in the form of beds of porous gravel or sand extending over many miles of territory, as, for instance, on Long Island. The rain-water percolates through the soil and fills the interstices of the gravel, from which it may be drawn at pleasure by driven wells or other proper means. It is found by experience in the Eastern States that the storage in gravel, as well as in open reservoirs obtained by damming up valleys, may allow of a daily draft of from 200,000 to 700,000 gallons from every square mile of water-shed the rain-water of which can be naturally or artificially stored.

It will be seen, therefore, that, where the selected source in its natural condition is not sufficient to supply the community in the summer months of the dryest years, a careful investigation as to the best and least expensive means of equalizing the flow of the streams throughout the whole year will be necessary. The best examples of this kind in our country are the water-supplies of New York

city and Boston, where well-devised systems of storage have rendered comparatively small rivers available to furnish large daily supplies.

Of still greater importance is the question of quality. In former times taste and appearance alone guided the selection of a source, but we have learned that a palatable, clear, and sparkling water may contain poisons or pathogenic bacteria in large quantities, and now we specify that it shall be free from mineral and organic or sewage pollutions. There are many cities where the supply does not fully answer these requirements. The expense of making changes in existing works, or even a surprising lack of appreciation of a more wholesome water, are the reasons. We may instance Philadelphia, with its sewage-polluted Schuylkill river, and the several large cities along the Ohio river, nearly every one of which takes the water unpurified from the river and subsequently discharges its filth into it to injure the healthfulness of the water taken by the towns below.

It is now well demonstrated that certain diseases are caused by certain bacteria, introduced into the body in many cases by means of the water-supply; and it is likewise well demonstrated that we can purify such polluted water and again render it healthful. Nothing but financial inability can now be held as an excuse for not furnishing a pure water.

The low death-rate from typhoid-fever cases in London and Berlin, since the filtration of their water-supplies, is clearly traced to the effect of the filters. In Zurich the typhoid mortality was four per thousand before the introduction of filters, and was reduced to four-tenths per thousand thereafter. Hamburg and Altona, forming virtually one city, but having different water-supplies, furnish another striking case. The former city was drinking unfiltered water from the Elbe, and in 1892 was visited by a terrible cholera epidemic, while Altona, which was supplied with water from the same river below the sewer outlets of Hamburg, but after the water had been filtered, was practically free from the scourge.

The most recent of such demonstrations is in the case of Lawrence, Mass. Its water, taken from the river, contains the sewage of Lowell, situated about 10 miles above. The records of many years show that a short time after a typhoid epidemic had started at Lowell a similar one started also at Lawrence. In September, 1893, filter-beds were brought into use to purify the water for the latter city. Since then another epidemic has existed in Lowell, but for the first time has not been followed by one at Lawrence. Grounds for expecting this result were known to rest in the fact that under certain conditions the typhoid bacteria, although contained in the impure water, do not pass through a filter properly constructed, but are destroyed in it. It is

possible to-day, through artificial purification, to utilize sources which formerly would not have been considered.

The many uses to which water is now being put, and the continual increase of population in our cities, make the quantities required so great that springs and mountain brooks do not suffice, and rivers draining large areas must be brought into use. Some of these areas are populated or cultivated to some degree, rendering the water turbid and impure by the admixture of sewage and other waste organic matter. It would be impossible, therefore, in many cases, to furnish large communities with water at a high degree of purity, were it not for the means now in the hands of engineers whereby water which has been subject to pollution may be made pure and safe for consumption.

There are several ways in which an artificial purification of a city's supply may be brought about. The aeration of water may often serve a useful purpose by preventing stagnation in reservoirs and removing any disagreeable taste due to certain gases or a solution of iron. Agitation with certain materials in a fine state of division—for instance, coke or charcoal—has likewise been found an excellent aid to purification. Dr. Frankland found that water could be made absolutely sterile by this means. Agitation with small particles of iron in a revolving cylinder was used to purify the water-supply of Antwerp.

Simple storage in a reservoir allows much of the suspended matter, and sometimes a large proportion of the bacteria, to settle to the bottom, and thus improves its quality. Again, Dr. Frankland found in a number of cases that raw river water running into one of the reservoirs in London contained from five to ten times as many bacteria as the water running out of the same. A further improvement can sometimes be obtained by adding to the water solutions of certain salts of alumina or of iron, before it enters the reservoir. Yet this necessitates frequent cleaning out of the deposit.

A straining through specially-constructed mechanical filters of sand or other granular material, with or without the addition of precipitating salts, has been found to be of excellent service in clarifying, and to some extent purifying, turbid waters. Atlanta, Ga., is probably the largest city where such means for clarifying the entire water-supply has been successfully used. The most perfect and practicable process of purifying water is by slow filtration through sand. European scientists have made many investigations on this subject, but the Massachusetts State board of health has conducted a series of experiments on a large scale in so thorough a manner that it was able to formulate in its annual reports the principles of this method of purification in a more definite, tangible, and practical manner than was possible before. The latest published statement regarding the results

of the experiments was made at the Montreal meeting of the American Public Health Association, in September, 1894.*

The best material is pure sand of a certain degree of fineness. Its active depth should be at least 2 ft., and it is found that 1 acre of sand can purify several million gallons of water in 24 hours under favorable conditions, so that practically all the bacteria may be removed. Usually the filters for water-supplies are operated continuously; the new filter in Lawrence, Mass., was designed to operate intermittently, by which a higher degree of efficiency is expected.

After a source of supply has been selected, and storage, if necessary, provided, it then behooves the officials to see that the water is distributed throughout the city by means of suitable pipes at suitable pressures, and in the least expensive manner. The uneven rate of water consumption throughout the day and night, and the sudden demand for large quantities in one locality in case of a conflagration, make it desirable in most cases to have a distributing reservoir near or in the city, into which the water is uniformly delivered by gravity, or by pumping, and from which it is drawn through the distributing pipes in accordance with the demand. Sometimes such reservoirs are impracticable for topographical reasons, as in Chicago, and then ample means for pumping directly into the mains, with facilities for quickly responding to the changes in the draft, must take their place.

The water-pressure must be neither too great, straining the fixtures or leading to waste or inconvenience, or too light, giving insufficient discharge. Water should be expected to flow freely in the upper stories of all ordinary buildings. In hilly cities it is often necessary to have a high- and a low-pressure service, each requiring a separate system of distributing reservoirs and pipes.

The pressures in the pipes should ordinarily range from 20 to 80 pounds per sq. in. Where they are high, and where the loss of property due to fires cannot be very great, it is customary to utilize the pressure in the pipes, instead of fire-engines, for putting out fires. When this is to be done, the designing engineer must see that sufficient pressure exists everywhere for this purpose, so that, with the greatest hose-length in use, and under other usual conditions, enough water can be thrown upon the fire.

It is a common mistake, due apparently to motives of supposed economy, to make the pipes or mains too small. It is not unusual to find them only 4 in. in diameter or less, when supplying extensive territories. In case of a large fire, the draft upon such a pipe is so great that the pressure and the supply become seriously deficient. The sizes

*"Sand Filtration of Water." By George W. Fuller. *Journal American Public Health Association*, January, 1895.

should be so proportioned that, both for fire and domestic purposes, the quantities and pressures in any part of the city will be ample.

It is a matter of importance, particularly where the water is not of the best quality, to so unite all the pipes that there can be a complete circulation, sometimes in one and sometimes in the other direction. So-called "dead ends," or the abrupt termination of a pipe, should be avoided, because a stagnation of the water is possible. Furthermore, when there is a sudden change and a large draft at one point, a circulatory system will permit the water to be drawn at a given point from both directions, thus more than doubling the quantity available.

The net-work of the distribution requires still further attention. With a main in every street, it sometimes makes a considerable difference in the total cost whether the largest pipes are laid through the middle or along the periphery of a certain district,—the most economical location being, as a rule, through the streets where the greatest draft is expected. Every locality has its own economical problems, which a competent engineer will not overlook.

The distributing mains should be capable of being cut off by valves at suitable points, so that, when repairs or new connections become necessary, only a comparatively small district need be deprived of water. A careful study may make it practicable to economically shut off no more than two or three blocks at a time.

Hydrants should be placed sufficiently often to control a fire occurring at any point. It is customary to have from ten to fifteen to every mile of pipe in residence districts, and from twelve to fifty per mile in business districts where valuable merchandise is concentrated. Yet it must be remembered that a closer grouping of hydrants will not alone suffice to deliver a greater quantity of water. The sizes of the mains must correspond to the frequency of the hydrants.

Space does not permit us to consider the ways in which city authorities should control the use of water by the people, and regulate the plumbing so that waste and damage shall be prevented. Suitable ordinances should be adopted to protect the supply from misuse and prevent it from endangering property.

The method of paying for water should likewise receive careful attention. Measurement by meter should be adopted wherever practicable, as the fairest method both for the consumers and for the city, provided there is a fixed minimum rate which permits of an ample amount of water for legitimate use. Instance the city of Atlanta, where over 89 per cent. of the quantity consumed by private parties is metered, with the result that waste is materially reduced, and the *per capita* expense of pumping and purifying the water is kept very low.

When meters are not used, the charges should be governed as nearly

as possible by the ratio of the quantities probably consumed. Unfortunately this is not always the case, as the usual water tariff frequently contains rules which favor some consumers and unjustly impose greater charges upon others.

Finally, an important question for city officials to consider is the ownership of the works,—whether the city shall own them, or a franchise be awarded to a private corporation to supply the water to the inhabitants. Over one-half of the water-works of the United States belong to private companies. The largest cities, however, are generally found to own the works, while in the newer sections of the country, or those which develop less rapidly, we find a higher percentage of private works. One reason for this lies in the fact that the larger cities, having better credit, are better able to raise the necessary capital; another lies in the feeling that in large cities the works can be better managed in the public interest. Therefore we find that, of the fifty largest cities of the United States, seventeen have, within the last 50 years, changed from private to public ownership, while but one city* has sold its works to a company. Nevertheless, it often occurs that for financial reasons, or on account of a prejudice against incurring a greater debt, serious objections are urged against a town owning its works. It is not always realized that by the franchise system the taxpayers generally assume a greater burden than by public ownership. Still there are many cases where private companies are preferred, and are even necessary, to enable the inhabitants to secure the benefits of a supply. It then becomes exceedingly important that the city officials thoroughly inform themselves of the many intricacies of the subject before granting the franchise, so that they can properly guard the interests of the citizens. Before awarding a franchise, the wisdom is apparent of thoroughly investigating the claims of the promoters, the character and full extent of the proposed supply, the storage facilities, the intended distribution system with its appurtenances, and the available pressures and deliveries, with reference to domestic and fire supplies. The proposed pumping machinery and purification plants, if needed, should also be subjected to careful scrutiny, so that they will undoubtedly do the intended work; and, lastly, the estimated cost of the entire system and the proposed tariff charges, both for public and private purposes, should be conscientiously considered, so that not only a reasonable profit may accrue upon the invested capital of the company, but a protection against ill-proportioned or exorbitant rates be guaranteed to the citizens.

* New Orleans, La., bought its works from a company in 1868 and sold them to a company in 1878. *Manual of American Water Works for the year 1891.*

POWER, LIGHT, AND HEAT IN CITY BLOCKS.

By J. E. Talbot.

IN considering the question of the cost to the consumer of obtaining a supply of electricity for lighting or power, it is very commonly assumed that, unless the quantity required is likely to be very large, the most economical plan is to arrange for receiving a supply through the street-mains from the most available central station. This, as a general proposition, may be admitted without question, but it is an old maxim that "*cessante ratione, cessat lex ipsa.*" If the very causes that have been instrumental in the spread of central-station lighting to the partial exclusion of isolated plants are, in some cases at least, no longer operative, then the whole question is re-opened.

The controlling considerations which led to establishment of the system of central lighting and power stations were the greater economy of large units, the longer "hours of earning," and the lower cost of operation due to the centralization of business and *personnel*,—the same centralizing tendency which leads to the formation of our much-berated "combines," monopolies; and trusts. It is true that it would scarcely pay a consumer requiring not more than one or two hundred incandescent lights to instal an isolated plant, provided it were practicable to obtain current from the street service at a fair price; and it is further true that a large number of the existing isolated plants were put in operation at a time when, or in a situation where, a reliable central-station service was not available. Let, however, the capacity of the plant be increased to 100 or 200 h. p. or upward; then we begin to approach conditions comparable with those of the central station. Take, for example, the case of a large "block" or "square" in one of our principal cities, and we find a population or occupancy equalling or exceeding that of a fair-sized town. Such a block may contain a hotel, a theatre, an express office, a newspaper office, and stores of various kinds, as well as a number of light manufacturing industries, so that the power required in the form of electric current for lighting, for motors, and, in an increasing degree, for heating and cooking purposes, may easily run up into hundreds of horse-power. Such a block, with the buildings upon it, may easily have a value of several million dollars; it may belong to one or several owners, and may possess a portion or all of the above-named characteristics of occupancy, and even more. These and other considerations materially modify the conditions of the problem in different cases, but in all there will certainly be the requirement of *light*, and, in nearly

all, that of *heat* (almost universally in the form of steam distributed to radiators), as well as *power* for elevators, fans, sewing-machines, lathes, pumps, and tools of different kinds. This being so, it becomes necessary for the proprietor, or proprietors, to provide some kind of steam plant, or, it may be, more than one, at a cost of several thousand dollars, and also to provide skilled labor for the operation and maintenance of that plant. The tenants may obtain their light and power from the owner, or they may provide them independently of him.

Now, following out the very principle of centralization and economical operation which has led to the establishment of existing stations for the distribution of current, let us assume that the proprietor, or combined proprietors, establish a central station of their own for all purposes within this block adapted to service by the electric current; then the question arises: Is there not in such a condition the potentiality, not only of economy in actual requirements, but also of some profit? And in both cases would these not be greater than they would if the necessary current were purchased at the usual rate from a company operating a central station, assuming such to be available? The answer to such an inquiry must depend upon various considerations. In the first place, such a proprietor already has the real estate and buildings, as well as the steam plant, subject to the necessary increase required; he has already provided the necessary fuel, labor, and supplies, subject also to some increase; the wiring and fixtures would be furnished by him in any case. Against this, he will receive a considerable revenue from his tenants, which would otherwise go to the gas or electric-light company. It is true that in the operation of his plant he cannot expect to obtain as high a degree of economy as is possible in a large central station, but, as a set-off to this, there are many expenses that he would not have to bear. Eventually it is the *consumer* that is depended upon to make the central station remunerative. He it is, in the end, who has to pay the dividends, the interest on the capital invested in the real estate and buildings, the steam and electric plant, and the complicated and expensive system of canalization. He has to pay the salaries, wages, taxes, insurance, and bad debts; if the revenue will not meet these charges, more revenue must be extracted from the consumer, or the central station must stop business.

No very exact figures can be given as to the actual additional cost of providing electrical facilities of the kind suggested, but some data may be presented, throwing a little light on the question. The quantity of additional fuel needed can be approximated by estimating a consumption of 5 lbs. of coal per h. p. hour, which, at $3.00 per ton,

gives a fuel cost of ¾ of a cent per horse power (say 10 16-c. p. lamps) per hour. Considering the staff of engineers, firemen, janitors, watchmen, etc., which would necessarily have to be carried on a plant or establishment of this nature (even if an electrical outfit were not provided), some one of whom would necessarily be on duty at all times during the 24 hours, the *additional* labor required would be comparatively little, while the extra oil, waste, water, and sundry supplies would be but a trifle. Steam at a pressure of perhaps 120 lbs. would be used, if the most economical engines were employed, but the entire heating of the block could be taken care of by the exhaust steam, from the various engines if the heating apparatus were properly installed to prevent back pressure. If electric elevators are used, the cost of a hydraulic system is, of course, saved, to say nothing of electric as compared with hydraulic means.

It is not to be assumed, of course, that every city block is adapted to such a light and power service as that which has been suggested; the writer has, however, now in his mind an actual instance of a block containing one large hotel of perhaps five hundred rooms, one large newspaper establishment, four restaurants, several small industries (such as tailoring, metal working, electro-plating), Turkish baths, a drug store, a book store, telegraph offices, many private business offices, and a police station to look after the morals of the whole. Five thousand incandescent lights connected, with some multiple circuit arc lights (and perhaps a search light for the police station), would not more than fulfil the requirements for illumination, and with say eight or ten elevators, together with printing presses, sewing-machines, laundry apparatus, tailors' heating-irons, soldering-irons, coffee urns, and motors for ventilating and light manufacturing, some 250 to 300 kilowatts in the form of light, power, and heat are plainly "in sight."

That great desideratum, a constant, or at least a continuous, load throughout the whole 24 hours, can be more nearly realized in this case than with the usual isolated plant. Take, for example, the case of ten elevators; some of these will run say 10 hours a day only, others 15 to 18 hours, and one or two day and night. For an elevator having a load capacity of 1000 lbs. and running 240 ft. a minute, a maximum horse power of 15 may be allowed, while the *average* load will not exceed one-third of this; allow, therefore, 50 h. p. Then, again, as to incandescent lights (or arc lights on parallel circuits) in such a block as we are now considering, although naturally the bulk of the lighting would be from 4 p. m. to 11 or 12, yet a number of lights would be needed all day or at intervals through the day. Kitchens, the back part of restaurants, cellars, laundries, billiard-rooms, hallways, inside offices, vaults, porters' rooms, lavatories, &c.,

would provide an all-day load which, on a total number of 5000 to 6000 lamps connected, would not be over-estimated at 30 to 40 h. p. Motors for light manufacturing work, fans for ventilating, and motors for washing-machines and a variety of other purposes, will also add to the earning capacity of the plant during the day time, and then, in the slack hours from midnight until early morning, there would be the newspaper press-work in addition to the lighting of the newspaper offices, exterior arc lights, and incandescents in the hotels and elsewhere. Thus, it will be seen, no inconsiderable portion of the electric installation would be continually in operation, and, by a judicious selection and arrangement of units, could be kept working at maximum efficiency at all times.

It may be objected, it is true, that we are proceeding on an unwarranted assumption that the light, heat, motive-power, ventilation, and the like, provided for occupiers will be appreciated by the tenants on a money basis, so that a reasonable return on the investment may be anticipated. In New York, Chicago, Denver, San Francisco, Cleveland, and the other modern and progressive cities we think there can be no question that offices, stores, workshops, and other places supplied with such conveniences would find tenants much more readily, and at higher rentals, than the old, dingy, stuffy, gas-befouled premises of a rapidly-disappearing era, some of which are still to be seen in our more "conservative" cities. In modern building indeed, it is frequently the case that electricity is the only illuminant for which provision is made.

In the absence of definite figures only an approximate comparison can be made of the cost of production of electric energy in such a plant as that under consideration, with similar cost in a central station, but the analysis of data from a number of central stations shows that the actual cost (omitting interest on capital and dividends) of delivering one kilowatt-hour* to the consumer does not exceed 7 cents, and is in some instances considerably less, while the price charged averages about 20 cents. The cost of fuel, under central-station conditions, averages from 1/5 to 1/4 of the total operating expenses, and, although a "block" plant could not anticipate quite as high a fuel efficiency as a well-managed central station, yet in such a case the other items (making up the greater part of the cost) are either absent or largely reduced. No provision has to be made for paying dividends on watered stock; no large salaries to superintendents and experts; no wages of inspectors and outside men; no repairs or maintenance of

*For the benefit of the non-electrical reader we may explain that a kilowatt is equal to about 1⅓ "h. p." The "watt" is the electrical power-unit, and the ordinary lamp of 16 c. p. requires from 50 to 60 watts.

outside conductors ; no additional real estate and buildings ; trifling loss in conductors from station to consumer ; less taxes and insurance ; and less expenditure for repairs. The whole installation would be directly under the eye of the proprietor, or man in charge of the plant, and changes in wiring or repairs could be made at cost by an employee of the establishment. As to the method of charging the tenants, the price of their supply, might, as to light, be included in the rent, or be fixed by contract (so much per lamp per month) or by meter, according to circumstances. Motors are customarily owned by the consumer, and power is charged for at their rated capacity per month, the tenant using all or any portion when and as he pleases. The details of the service will regulate the price to be charged, in the absence of a fixed rate per kilowatt by meter. Thus the running of ventilating fans may be considered almost a continuous full-load service ; the elevator service is intermittent and variable ; sewing machines, lathes, drills, &c., intermittent and of small average,—so that the actual power consumed in any given period may be three or four times as much in one class of service as in another of nominally the same capacity. We do not, however, purpose here to deal with the details of this work ; these must, from the nature of the case, be left for consideration in connection with the individual instance.

The use of storage batteries to relieve the dynamos for the supposed comparatively short period of maximum load might suggest itself. It is believed, however, that in the present state of that art in this country, taking all circumstances into consideration, this would be an advisable addition.

In the foregoing remarks it has been taken for granted that occupants of offices, stores, or premises of the class involved in the consideration of this subject will avail themselves largely of the conveniences afforded ; but occasionally an individual might be encountered who has derived his ideas of life from the Plymouth immigrants or from the period of William Penn, and to him these "new-fangled" notions might seem distasteful ; yet, after a short actual experience of the resources of modern civilization, he who "came to scoff" would "remain to pray."

By no means have we dealt with every aspect of this question ; rather would we suggest matter for elaboration and inquiry, the local conditions in every case materially affecting the problem. At the same time it does seem certain that in very many instances such a "block" plant as has been suggested would enable complete electric service to be obtained under conditions where otherwise it could not be had, or at least not so readily, conveniently, or economically.

WOOD-STAVE PIPE FOR CONVEYING WATER.

By Arthur Lakes.

"NECESSITY is the mother of invention" is a trite saying. We may add that simplicity is generally the character of important inventions. Both these observations seem illustrated in Mr. Allen's invention of the wooden stave pipe, which, some think, will revolutionize the long high-pressure conduit system.

Any one who has passed through a frontier experience knows the wonderful fertility of invention as well as power to adapt materials displayed by the frontiersman when he has to rely wholly on himself, there being no stores at which to buy this and that. He looks around him to make what he can out of what lies nearest him. In the backwoods of Canada a woodsman can make almost anything out of wood with his axe. Give a frontiersman on the plains a good supply of tin cans, and he will do anything—from shingling his dug-out to making a set of dinner-ware or a lantern. So, in the present instance, the necessity of bringing a long and voluminous supply of water to Denver from the mountains many miles away led Mr. C. P. Allen, chief engineer of the Denver water works, to look about him for some material less costly than iron or earthenware, capable, too, of a larger diameter and capacity than the ordinary metal pipes. He settled upon that material which lay nearest him, and the cheapest,—*viz.*, wood; and the wooden stave pipe was evolved. It seems now as if, by an unexpected and retrogressive evolution, the conduit system was about to evolve from an iron and earthenware age to a woodenware age. Nor is this evolution unparalleled or without analogy. The early backwoods architecture evolved from a wooden age of log cabins and wooden sidewalks to one of brick and stone. Nevertheless in many parts of America, notably in California and on the Pacific coast, wood has shown itself the fittest, and the cheapness, lightness, and elegance of the California redwood buildings have caused them to supersede the more massive structures of brick and stone.

Nor was it in the present case a mere temporary makeshift of no durability, for the wooden material bids fair to equal, if not to outlast, the oxidizing iron and frost-cracking earthenware; and water carried by it is not contaminated by rust, oakum jointage material, or other impurities. Its advantages and virtues, however, we shall reserve for a later place in this article.

The cause that led Mr. Allen to invent the stave pipe was the condition of the water works of Denver.

BEGINNING OF A SECTION AT RAILROAD SIDING.

SECTION COMPLETE.

BEGINNING OF THE BUCKLE.

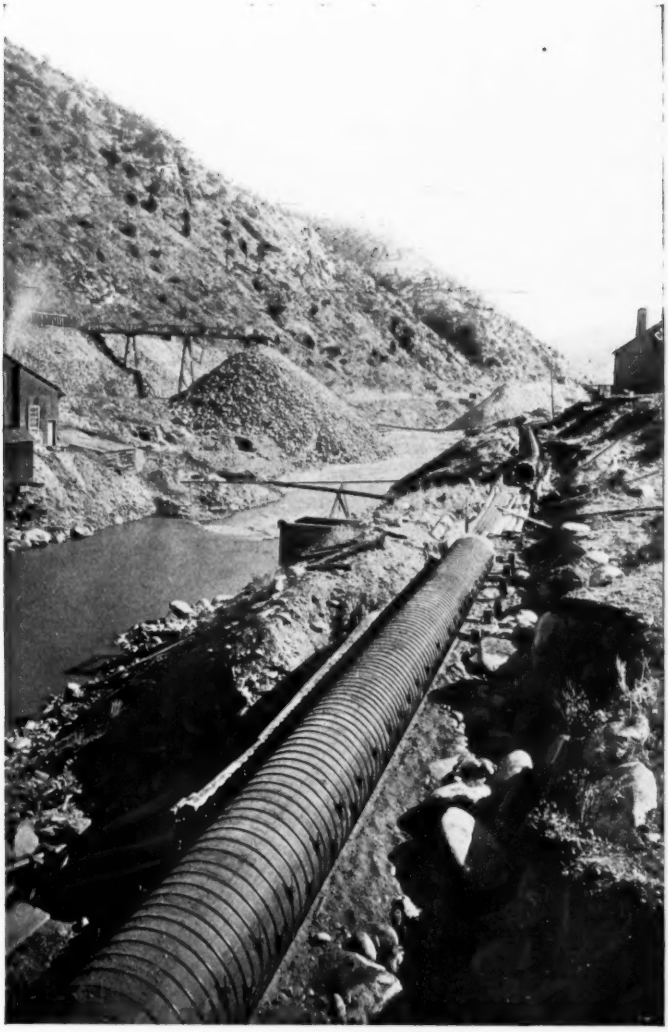
These works, in their infancy in 1871, consisted of a pair of Holly pumps drawing water from a large well in the gravel bed of the Platte river. There were then but 6000 inhabitants. In 1879 a higher source of supply was sought above the sewage contamination of the city. New works were located in West Denver, where it was possible to utilize the water power of the river; and a canal 2 miles long, called Archer lake, was built from the river with a vertical fall of 30 ft., and also a battery of turbine wheels and set of four Holly horizontal pumps. The canal accumulated much silt and vegetable matter, so that in 1884 the company decided to seek a purer supply higher up stream by developing the underflow in the gravel beds adjacent to the river. The development was planned and executed by Mr. Allen, and was the originating motive for the evolution of the wooden stave pipe, which has since come into extensive and general use.

The grade from the gravel beds to the works was so slight that a very large pipe was needed to carry the volume of water required, and the maximum pressure upon it was so low that there seemed to be an especially good field for the employment of material cheaper than iron. It was finally decided to lay a wooden stave pipe 48 in. in diameter, banded with steel rods, the top to be of California redwood, the lower part of Colorado pine. The cribs or galleries gathering the water and feeding the pipe were made of rough lumber 4 ft. wide and 1 to 4 ft. high, with open joints, the tops of which are some 6 ft. below the bed of the lower water surface of the river. The water filtering through gravel was clear and pure and a great improvement on preëxistent conditions. The pipe terminated in a 12,000,000-gallon reservoir. From the reservoir the water was pumped into the mains.

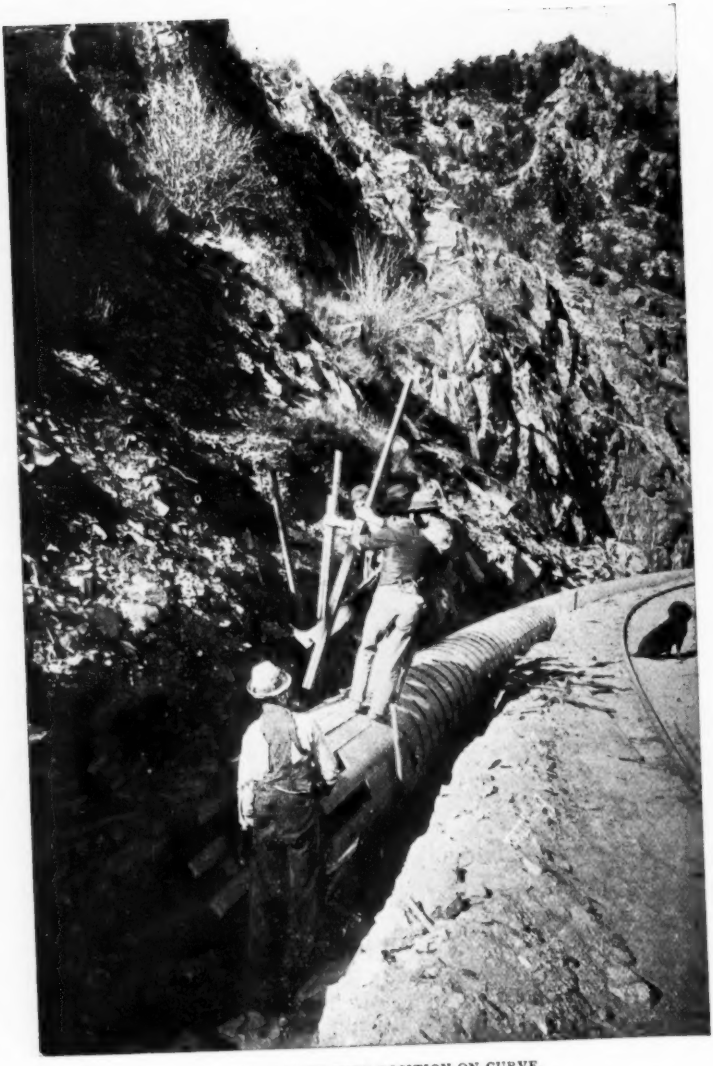
The success of the Platte underflow led to similar developments on Cherry creek, which heads in the high table-lands of the Divide. The slope of the area rendered it practicable to bring over its underflow on a short conduit, and in 1886-7 a wooden stave pipe 37 in. in diameter and 5 miles long was laid to tap a system of semi-circular cribs sunk in the bed of the creek 25 ft. below the surface. When this pipe was completed, the flow into the city reached 9,000,000 gallons daily.

The Citizens' Company was the next to adopt the stave pipe; one 30 in. in diameter was laid from Platte cañon for 20 miles, 16 miles of which were of stave pipe. The wooden pipe was banded to withstand a maximum pressure due to 185 ft. static head.

The total number of band sused was 271,900, which, divided by the length, gives an average spacing of 3.86 in.—sufficient for an average head of 70 ft. throughout. The cost of this wooden pipe was very moderate: 1,869,000 ft. of B M Texas pine, surfaced, at $27.50,



GENERAL VIEW APPROACHING SECTIONS.

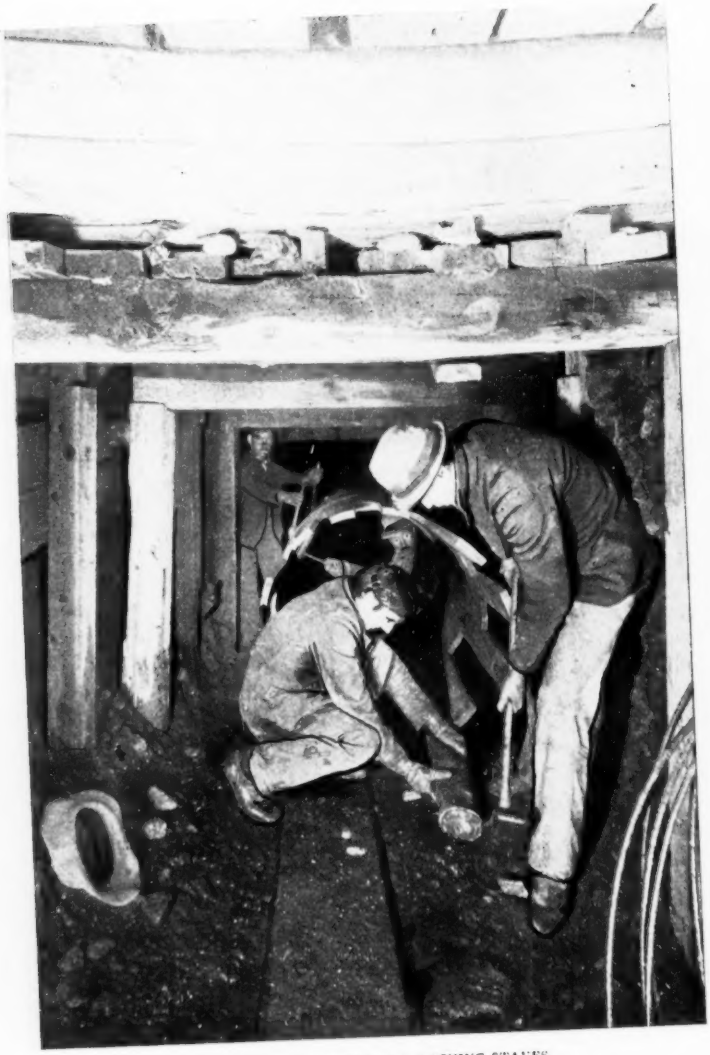


SWINGING PIPE INTO POSITION ON CURVE.

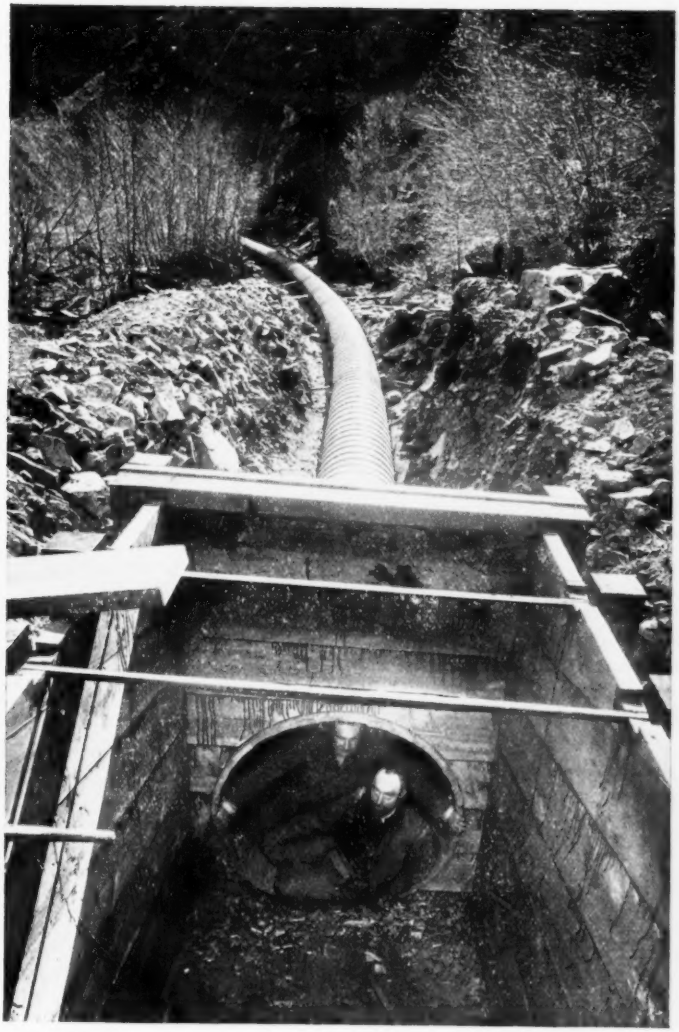
$51,399.28; 271,900 ½-in. steel bands and shoes, $54,299.03; erection of pipe at 5.1 cents per band (contract), $13,856.03; total, $119,564,86,—an average of $1.36½ per foot. This wooden pipe, having a smooth interior which becomes smoother with use, has a greater carrying-power than cast iron of equal diameter. A still larger pipe of 34 in. diameter, and another of 44 in., were added later. On one occasion, having to make a temporary arrangement with a high line ditch to use its tunnel and take its water by a waste gate into the 30-in. pipe, a short flume, forming a spanning bridge, was made, which showed admirably the strength of the wooden-pipe system. It was made of two 13-in wooden pipes 104 ft. long. These pipes were spread apart 12 ft. at the ends, and brought together at the center for a distance of 20 ft., where they were tied with iron bands. This, which was intended as a cheap temporary crossing, was novel and proved stanch and effective. The arch was built on light false work and finished in a week. The pipe was then filled with water, and used as a foot-bridge, showing little vibration. "Thus," says Mr. Schuyler, in his report on the Denver water system, "the entire supply of a city of 150,000 people is conveyed in wooden pipes or mains,—a novel idea, but one that has achieved an enormous saving of cost and has proved eminently successful."

I had a good opportunity of studying such pipe, in all its progressive stages of construction to its final completion, at the Stanley consolidated mine, above Idaho Springs, Colorado, where it has lately been introduced to carry the water of Clear creek under high pressure to a water-wheel working the air-compressing engine of the mine. Standing on the high dump of the mine, and looking down on the pipe below, it reminds one of a gigantic red worm winding along the sinuous banks of the creek beneath the steep cliffs of the cañon. The pipe is about 1 mile in length and 36 in. in diameter, and carries water at high pressure down a gradually-descending grade to the water-wheel near the air-compressor. The pipe is painted red and made of boards of prepared lengths of Texas pine. Each board is dressed into a slight section of a curve of the pipe. The pipe is hooped with mild steel bands from end to end, the hoops coming much closer together towards the lower end, where the pressure is greatest. The boards, or staves, have a thin tongue of metal at the end, which is driven into a corresponding groove in the next piece, making a firm joint. A bend also along the side of the board, when driven home, makes a tight fit between boards without the use of oakum.

The round steel bands are joined by an ingenious and very simple device. The band or rod has at one end a square head of special form, and at the other a thread is cut 5″ in length, for which distance



BUILDING PIPE IN TUNNEL, DRIVING STAVES.



SHOWING INSIDE CONNECTION OF PIPE TO PENSTOCK. PIPE 48 IN. DIAMETER.

the rod is upset. The threads are cut of less depth than the standard thread, and the nuts are made thicker than ordinary. The bands are shipped as straight rods in bundles, bent on the ground by hand around wooden tables. They are dipped in asphaltum or painted with red paint. After the bands are in place on the pipe, the threaded ends are again painted before the pipe is covered with earth.

The coupling shoes are of malleable iron. A recess near the bottom of the casting is made to receive the head on the end of the band, and the slot in the top receives the threaded end of the band directly over the head.

The first step in construction was to build a dam and penstock. Then a trench was dug 4 to 5 ft. deep to receive the pipe, and a little wider than the pipe that the men might work by the side of it. This was mainly in loose river drift. In one or two places they had to make a short tunnel. The next step after the material and hoops were all on the ground was to lay down two U-shaped outside forms on the bottom of the trench 10 to 12 ft. apart; on these the bottom staves were placed, with the tongues on the ends to join the bottom half of the pipe. Inside of this was placed a ring of proper size. The remaining staves were added separately, and the nuts partly tightened. The staves were then coopered out to complete the true circle. When the pipe was round and true and all the staves drawn up tight at the butt-joints, the bands were again cinched up tight and firm. Finally earth was tamped all around the pipe, the pipe was covered up, and the trench refilled.

A pipe laying gang consists of eight to sixteen men. Where the pressure is heavy and the bands are but 2 or 3 in. apart, a larger gang is required than on light-pressure pipe, half the gang being employed on the final cinching and finishing of the pipe in the rear of those who set up the pipe and place the bands. On a long pipe gangs are placed every 1500 ft., and, where gangs working in opposite directions meet, the coupling of the ends is effected by cutting the staves about $\frac{1}{8}$ in. longer than the space they are to occupy and springing them in position. The bands, closing tightly together, make the butt-joints at the coupling really tighter than they are ordinarily. Soon after the pipe is laid, water is slowly admitted, and the pipe left to soak it up until the full pressure is on. All minor cracks and leaks will gradually disappear, and serious ones are easily located and stopped. Air valves, blow-off gates, and stand pipes are located where required. Both California redwood and Texas long-leaf pine may be used in the construction.

At the point of connection with the water-wheel with its large iron cups the iron saddle is shown, with a man's face looking out of the hole in it.

THE NOZZLE IN ITS FOUNDATION.

PIPE CONNECTION TO PENSTOCK OF OPEN FLUME—BEFORE BANDING THE PIPE.

Among the advantages claimed for this stave pipe are its cheapness and capacity for great dimensions.

Wood, when buried or water-logged, has often been found wonderfully durable. Old pine log pipes 5 in. in bore laid in 1797 were found sound when dug up in 1870. The old water-logged remains of the ancient lake dwellers, after perhaps thousands of years of immersion, have been dug up in a comparatively sound condition. The bog oak of the Irish swamps, contemporaneous with the mammoth and great elk, is famous for its hardness and preservation.

The interior remains smooth, and the diameter is never decreased by rust incrustations or tubercles. The passage-way is always clean and sweet, and contains no calking yarn or oakum to decay and pollute the water.

The pipe does not burst or break by settlement. It is continuous, with no positive end joints; it can be laid at a hundred different points at once, and the various sections coupled up without extra cost or delay. It is readily tapped and mended, and can be easily taken up and replaced without strain or injury to any of its parts. It can be built over mountains and comparatively inaccessible regions, as it is composed of pieces that are light and easily handled. It is equally strong throughout, all its joints being broken and the bands spaced to the exact pressure at all points. It is built continuously in the trench where it lies, and not in sections made in the shop: hence there is no extra handling, loading, or unloading into the trench.

The metal tongues effectually prevent leaking, and the band forms a good joining, obviating the use of oakum.

Though at first used only in long irrigating or city water systems, it is now being applied to various other uses,—particularly as in the case of the Stanley mine, for working machinery in mining. As I write, a pressure pipe is in contemplation for bringing the waters of Clear creek to bear, under powerful pressure, upon giant nozzles for an extensive gold-placer undertaking.

HEATING AND VENTILATING TALL BUILDINGS.

By Leicester Allen.

THE tall office-building has come, and there is little to be gained in protest against it. It represents capital in one of its most arrogant manifestations. There is much profit in erecting and renting such buildings; therefore they will continue to be built. It matters not that no architect has ever yet succeeded in grafting beauty upon disproportion. It is of no consequence that these piles rob lesser buildings of their share of air and light, or that they are offensive to adjacent owners. Nothing matters much nowadays but dollars. Dollars must be gathered in, even if the harvest leaves behind it widely-distributed dolors. It seems to those who have more dolors than dollars that many who are now making large investments in tall buildings ought to rest satisfied without further effort to amass wealth; but money-getting, like dram-drinking, never satisfies the appetite it creates.

The tall building, let us hasten to acknowledge, has some excuse for existing, notwithstanding its esthetic defects. It affords, in many respects, accommodations for offices that never were provided till it came into being. With its rapid-transit elevators, its electric lights, its efficient janitor-service, its broad views from the higher windows, the breezes that cool in summer, the concentration of business it effects, it is attractive enough to entice tenants, and is generally well occupied, notwithstanding two great defects.

The tall building is almost universally badly heated and as badly ventilated, and in these respects it is unsanitary. There are generally heat enough and ventilation enough, but neither is of the right sort. The heating is excessive for mild weather, and the ventilation, only obtainable by opening windows, creates murderous drafts, so that many prefer to keep windows closed rather than take the risks ventilation imposes. In these respects the large majority of tall office-buildings are death-traps, and will so remain till the better methods of heating and ventilating them, now in their infancy, shall become the rule instead of the exception.

An entirely new set of conditions has been introduced by the tall building, which heating and ventilating engineers have attempted to meet by old methods, or mere modifications of old methods, and it is not surprising that they have failed to get desirable results. Have they not failed? I assert that they have. Day by day I spend the hours in one of the best of these buildings. It was designed by one of

the foremost architects in America, and its heating-plant was put in by a firm of heating engineers in high repute. Yet I believe there is not an occupant of the building who would consider a dwelling so heated and ventilated fit for his family to live in. A dwelling-house in which the only escape from over-heating when the thermometer outside stands at from 35° to 40° F. is by opening windows would be justly regarded as intolerable by occupants, and it would be a disgrace to both the architect and the engineer who planned it; yet this, with very few exceptions, is precisely the condition in a large number of rooms in the tall office-buildings hitherto erected. I feel certain I shall not be accused of exaggeration by tenants, however much my statements may be opposed by owners and others interested pecuniarily in the erection and renting of these structures.

On the 29th of March business called me into the office of an architect in one of these buildings. The windows in his drafting-room stood open. His assistants had removed their coats. When I went out of the building, I went immediately to ascertain the outside temperature, and found it only slightly above 40° F. I found the same thing in other offices in similar buildings. The day was windy, and the drafts in these offices would be considered anywhere as sharp and dangerous. I observed that some of the women employed in these offices had endeavored by shawls and kerchiefs to shield themselves somewhat from the drafts. Coughing and sneezing everywhere betrayed the effects of these drafts, yet they were submitted to in the effort to avoid the discomfort of over-heating. In one office I observed a large screen placed between one of the occupants and a window at his back, while he continued work with the aid of an electric light, although the day was bright and sunny. Is it not true, then, as charged, that the heating and ventilation of this class of buildings would, as a rule, be regarded intolerable in dwellings?

Let us glance briefly at the conditions. In the first place the requirements for light in numerous offices in a single building necessitate a large amount of window area. The windows lend themselves kindly to the effort to tone down the unsightliness of the tall building, and so windows with arched tops and other fancy styles are introduced. The sashes do not fit the casements tightly, and every window is therefore a generator of drafts, even when closed as tightly as it can be. I have not yet seen tight windows in one of these buildings. Weather strips may be resorted to, but even these have failed in some instances to prevent sharp drafts in high winds.

It should be remembered that such tall structures are affected by winds far more than those only four or five stories high, even when the latter are isolated. The upper stories of the tall building have no

trees or adjacent dwellings to break the force of the winds; and what would appear only as a moderate breeze in the street is a fierce blast fourteen to twenty stories from the ground. It is well known to all heating engineers that the effect of a strong wind is to cool the space in the building near the side which receives the blast, and to drive the interior warmed air through crevices in doors and partitions, and even through the materials of walls and partitions over to the space on the lee side. Thus one part of a house on the same floor may be too cold for comfort, while another, not very remote, may be overheated. This effect is greatly intensified in tall buildings.

A feature of the tall office-building is the great size of its elevator-shafts. Thousands of people must be carried up and down each day. Three large, rapid-running elevators in a single building are common, and as many as six are sometimes used. There is also the continuous passage for stairs up through the entire building. The draft in these shafts is enormous. Every time a lower room is opened, some of its heated air escapes and rises up through these passages. This air is more or less vitiated by occupants of the rooms from which it escapes. The frequent opening of doors in the upper offices admits this warmed and somewhat impaired air, and if, in the effort to regulate heat, the transoms be resorted to, opening these often increases, instead of alleviating, the discomfort. I do not mean to say that these defects do not exist in buildings even five stories high, but I would emphasize the fact that they increase with, and almost in proportion to, the number of stories. They would be almost five times as injurious in a twenty-story building as in one of four stories.

The number of those who go in and out of the tall office-building is very much greater than in a building of moderate height. The entrance-doors during business hours are almost constantly swinging. The inrush of cold air at the bottom is great. As has been already intimated, there is plenty of air admitted in various ways, but the mere admission of a large volume of outside air, and the consequent forcing-out of an equal volume of inside air, while, strictly speaking, a kind of ventilation, is by no means good ventilation.

Now we are near the close of the nineteenth century, the most wonderful for its enrichment of scientific knowledge and mechanical resources in the history of the world; the direct steam radiator with valves operated by hand is generally admitted to be a device for heating rooms which gives the occupant the least facility for regulating heat of any means yet employed for the purpose; yet this is the system which heating engineers have generally employed for heating the tall office-building. The reason this has been so is not that a better system could not be devised, but that owners failed to realize the importance

of anything better. Engineers could have found a way to heat tall buildings that would give occupants control of the heat in their offices and also fairly good ventilation, had they been given free scope to apply existing means to the solution of the problem.

But owners have only just begun to realize the importance of better heating and ventilation. Those who have the shrewdness to perceive how much these improvements would enhance the rental value of their investments will find in a very few years that they have left their earlier competitors far in the rear. Were the supply of well-ventilated, comfortably-warmed tall office-buildings ample, those now heated with direct steam radiators fitted with common globe-valves and ventilated only by windows and crevices would soon go begging for tenants.

But the difficulties in doing this can only be overcome by liberal expenditure. No competent heating engineer would shrink from undertaking the heating and ventilation for a mansion, a school, a church, or a hospital. Architects have learned that such buildings must be designed, at least in some measure, with reference to obtaining a proper system of heating and ventilation. But in the tall building all that hitherto has been much considered by architects with reference to heating and ventilation appears to have been the provision of chases on the inside of the masonry wherein the steam-heating contractor may erect his riser pipes. But, unless architects coöperate with engineers as they do in those lesser buildings which offer the best examples of heating and ventilation, the tall building in these particulars will continue to be a monument of stupidity in both these professions.

Ventilation that does not necessitate the use of windows requires ventilating-ducts and -flues. Where is there a place in the tall office-building for these? Certainly not in the outer walls, as at present constructed. Hollow partitions wherein such flues could be placed would solve this part of the problem. These have never been adopted within my knowledge, and they are not likely to be, because they would increase greatly the cost of the structure. They would also necessitate the division of successive floors into rooms, each substantially on the same scheme, since the flues leading from any room must go to the top, or connect with some other flue leading to the top, of the building. This method would also absorb much valuable floor space, and, on the whole, probably would not be consented to by either owner or architect.

A prominent engineer in New York, Mr. Alfred R. Wolff, has utilized the overhead space in corridors for air passages to and from rooms, and has thus succeeded in introducing into the tall building a plenum system of controlled ventilation. The circulation is maintained by ventilating fan-wheels. But, as yet, only a few examples of this sys-

tem in tall buildings exist. Of these may be mentioned the building of Kuhn Loeb & Co., 27 Pine street, New York (thirteen stories); the Carnegie Office-Building, Pittsburg (fifteen stories); and the Keeler and Kimball Building, Rochester (twelve stories). These are each heated and ventilated in accordance with plans designed by Mr. Wolff, and two others to be similarly heated and ventilated—the New York Life Insurance Company's building on lower Broadway, New York (fourteen stories), and the American Surety Company's building, Broadway and Pine streets, New York (twenty stories)—are now in course of erection. Automatic regulation of radiators by thermostatic control of their valves is also comprised in Mr. Wolff's designs, and these two features are a long step towards remedying the evils complained of. Offices in tall buildings, for the most part, must continue to be heated each by a single direct steam radiator. If supplied with ordinary globe valves, such a radiator, if used at all, must be used nearly at its full capacity. No nice gradation between full capacity and no heat at all is possible with any direct steam radiator whose valves are closed and opened by hand. The use of several direct steam radiators of different capacities in a single room, one or more of which can be used as needed, would approach a controllable system; but this is clearly impossible except in large rooms, or suites of connected rooms in which doorways may stand open. Indirect steam-heating adds to the difficulty of obtaining space for ventilating-flues, and demands greater space for warm-air flues. It is impossible to conceive any practicable method of applying it to tall office-buildings, except by some such scheme as that which Mr. Wolff has adopted. The system must mainly be direct. The problem is thus reduced to finding a direct system, or a combination of direct and indirect systems, of heating that can be regulated, not only as a whole, but in each of its parts.

Electric heating at once suggests itself. Not only can an electric heater be so regulated as to impart to air and surrounding objects any amount of heat,—from nothing to its full capacity,—but it can be made self-regulating to any desired degree of temperature when controlled by a thermostat. Instead of an elaborate system of piping, conductors of small size can be used, which can be run in any direction, and which do not require any modifications of plans to render them practicable. But, as yet, the cost of heating by electricity is too great for such a purpose, and the economy of using exhaust-steam from the elevator pumps and the steam engines that drive the dynamos is so important that any system, to be acceptable, must include this feature.

A system whereby both the exhaust-steam may be used and, at the same time, the desired regulation of heat by occupants may be obtained

has been placed in the Criminal Courts Building in New York. This may have been elsewhere employed. I understand it is controlled by a patent. I shall avoid details, since any one familiar with steam and hot-water heating will be able to understand what are the proper appliances for carrying it out in any particular building, and this, or any other system, requires special planning in almost every case.

The system is one of hot-water heating. The circulating pipes which convey water to and from the radiators may be smaller than is required for ordinary hot-water heating, because the circulation is maintained and rendered substantially uniform in all of these pipes by mechanical means. This water returns from any line of radiators back to the cellar of the building at a nearly fixed temperature. Reaching the cellar, it is reheated by the exhaust in a condenser, which ought to have sufficient surface to completely condense the exhaust steam. The water so condensed may be then passed back to the boilers supplying pumps or engines with power, and used over and over in these boilers for power purposes. The water flowing back from the radiators, being thus reheated as much as the exhaust-steam will permit, may next be passed into a special water-heater, wherein it is heated still further to the prescribed initial temperature.

In such a system the radiators should each be provided with a by-pass, the valve in which could be so arranged with reference to the inlet valve of the radiator that, when the latter is closed to any degree, the by-pass valve will be opened to the same extent. In this way every radiator would be entirely independent of each or all of the others, and could be made to circulate just as much or as little of the heated water as desired.

The expenditure of fuel for heating proper is thus confined to that needed to add the final increment of heat to the water used in the system, after it has been passed through the condenser. The expenditure for power would be that necessary for the circulating and condenser pump, which, as the difference in pressure between supply- and return-pipes is small, could not much exceed what is needed to overcome the friction of the water in the pipes.

The current cost for fuel would be thus sometimes increased over that required for power. The increase in the cost of the plant over that now principally used would be the cost of the supplementary hot-water heater and its appurtenances, the surface condenser, and the circulating pump, and the extra cost of the radiators, which would need to have a larger extent of heating surface than steam radiators. If by-passes are used, one extra valve for each radiator will be required. The total increase of cost would, of course, vary with the size of the plant. Suppose that, for a building containing two hundred offices,

this increase might be $10,000. Allowing 10 per cent. for deterioration and 6 per cent. interest on the investment, the cost per year of the addition would be $1600, or $8 per tenant. The increase of cost of fuel and attendance would be easily covered by $800, which would make the total $2400, or $12 per tenant. An increase of rent of $1.00 per month for each office would thus pay for making all the tenants comfortable in any sort of weather. I think five times this sum would be gladly paid by most tenants who have experience of the inconvenience and discomfort of steam heat in a tall office-building. The assumed increase of cost is merely guess-work. I have not found opportunity to make a reliable estimate. The scheme is mentioned with the hope that it will lead to a reconsideration of the possibilities of hot-water heating for buildings hitherto supposed to be too high for its application in any form.

But improved heating and ventilation in tall office-buildings cannot be had without increased cost. It would be worth all it is likely to cost. The system of heating in the tall buildings above named, as I am informed, cost twice as much as the common system of direct steam-heating. I have not on that account the slightest doubt of the wisdom of the owners in adopting it. Not insignificant items in the cost are the calculations, preparation of plans, and supervision of the work during erection. The minutest details require careful attention, and in all parts the application of scientific principles and engineering skill is requisite. I predict that the tall office-buildings which are fitted only with the present rude system of direct steam-heating will in a few years find themselves sadly handicapped in competition with those that have adopted improved methods.

THE ADVANCES IN MODERN IRON-SMELTING.

By John Birkinbine.

THE United States is a new country compared with nations whose histories are traced for thousands of years, and all of its industries may therefore be classed as modern. But, according to the American gage, the production of pig iron is among our ancient industries, for authentic records give the date of the initial blast-furnace in the United States as 1645, with a possibility that some preceding works were furnaces and not forges.

In this paper the blast-furnace only will be considered, omitting reference to the forge or other processes by which ore was converted into iron; and the smelting of iron ores in the United States only can be given consideration, the limit of space permitting but a hasty *résumé* of the advances made in this country.

For two centuries this industry did little more than spread over a more extended area, its growth being an increase in the number of blast-furnaces, and its development chiefly an occupation of new territory. Masses of masonry inclosing the hearth, boshes, and inwalls of the blast-furnaces retained the original form, and gradually assumed larger proportions, but the changes in arrangement and in practice were slight. To deliver heavier charges of ore, flux, and fuel, hand-barrows traversing a bridge-house extending from a bank to the top of the furnace displaced to a considerable extent the baskets and boxes formerly carried upon the heads or in the arms of laborers, who ascended ladders leading to the tunnel-head; and other details were similarly improved. But for almost two centuries an American blast-furnace could be described as a stone stack seldom exceeding 30 ft. in height, into which iron ore, flux, and charcoal were fed, blast at atmospheric temperature being supplied by large wooden or leathern bellows operated by a water-wheel. Blowing cylinders made of wooden staves bound with iron bands were also used, and, later, iron cylinders gave greater blowing capacity to somewhat larger furnaces producing more pig iron. However, an average weekly product of 25 tons of pig iron and a continuous campaign exceeding 40 weeks were unusual, an output of 1000 tons of metal per annum being considerably above the average obtained from then existing plants.

About 1840 a combination of advances, among which were the construction of railroads, the application of steam to operate blast machinery, the introduction of the hot-blast stove to heat the air driven into the furnace, and the use of mineral fuel, brought about changes in

furnace construction, equipment, operation, and location; but up to 1850 a furnace stack which produced 2500 tons of pig iron annually would "claim the broom." The ample supply of mineral fuel and the possibility of assembling any desired quantities of coal or iron ore by railroad permitted furnaces of larger capacity to be erected at locations which had previously been undesirable, but which had other advantages. The improvement in tools and mechanical skill produced blowing machinery of greater power, and the use of heated air resulted in larger outputs from a given furnace, and reduced fuel consumption per ton of iron made.

Notwithstanding these important improvements, few American blast-furnaces had in any one year up to 1875 produced 10,000 tons of pig iron,—an amount certainly much in excess of what was obtained a quarter of a century before, but only about one-tenth of what is at the present time considered remarkable work.

The increase in size of blast-furnaces is well illustrated in Plate I, which shows the interior dimensions of three stacks: (a) charcoal furnace 35 ft. high, with a bosh diameter of 10 ft., and a capacity of 1225 cubic ft., which up to 1840 would have been reckoned as a large furnace; (b) an anthracite furnace built in 1875, which, although not the largest, surpassed in its dimensions the average of stacks then active; it was 55 ft. high, with a bosh diameter of 16 ft. and a capacity of 5250 cu. ft.; (c) a coke furnace erected in 1892, which has won renown as a producer of large quantities of pig iron; it is 91 ft. 4 in. high, 20 ft. in diameter at the bosh, and has a capacity of 18,200 cu. ft. It is larger than the average furnace now on the active list, but there are a score of American stacks which approximate the dimensions shown.

The changes from the small to the large crucible, the increased height, and the greatly augmented capacity are evident from an inspection of the plate.

The past two decades, or at least the last quarter of a century, show the true progress in pig-iron production, and represent an advance far in excess of what had been achieved in the entire previous history of the iron industry in this country, and fully as great as that achieved during a similar interval in foreign lands.

American blast-furnace managers are indebted to European specialists for much of the research into the theory of iron-smelting, but in no part of the world has this theoretical knowledge been applied with better result than in the United States, and the productive capacity of the furnaces of this country is a source of astonishment to metallurgists throughout the world.

The chemistry of iron-smelting cannot be said to have been ap-

preciated until after 1870, and the formation of such organizations as the American Institute of Mining Engineers, encouraging interchange of data among blast-furnace managers, resulted in breaking down traditions and establishing a fraternity of mutual helpfulness. As the theory of iron production was investigated, the true functions of the blast-furnace were realized, and, as a result, larger outputs were obtained with greatly reduced consumption of fuel per ton of iron.

In the older practice the mineral most accessible, or that which yielded iron most readily, was employed, and, although attention was given to quality, it was mainly applied to considering iron ores which produced "red short" or "cold short" iron, or to mixing them in suitable proportions when "neutral" pig metal was sought for. The chemist's function was to determine *how* certain elements influenced the quality of iron, and his work has grown in importance until at present he is practically dictator at the blast-furnace. But without the engineer to design blast-furnace structures and machinery, and the manager to intelligently direct the operations, the chemist's investigations would not have made possible the remarkable practice of the present time.

Accustomed to judge of pig iron solely by its fracture and grain, or by its behavior when cast or wrought, the blast-furnace manager naturally viewed with suspicion the assertion that small fractions of 1 per cent. of some elements would fit or unfit an iron for specific uses; and to-day few persons realize that in laboratories connected with blast-furnaces it is necessary to carry the determinations to a degree of nicety unknown even in the assaying of the precious metals. It is, therefore, unjust to apply the term "old fogy" to men who, having by persistent effort utilized the limit of their knowledge to advantage, were slow to grasp the new order of things which the chemist proposed.

Appreciation of the theory of iron-smelting, and of the possibilities of the blast-furnace, caused more powerful machinery to be designed to furnish blast to furnace-stacks of greater dimensions; and one of the advance steps was the enlargement of the crucible, as the managers recognized that the quantity of fuel properly burned in a given time determined the producing capacity of a furnace. Another step was to secure better utilization of fuel by increasing the temperature of the air blown, and by selecting ores which yielded iron liberally, or which demanded a small percentage of flux. As the problem of fluxing became better understood, the importance of employing fuel with a minimum amount of ash and of elements injurious to the iron made was also appreciated.

Instead of discussing results at specific furnaces or in certain dis-

tricts, it may be well to glance at the progress which this country has made in the quantity of pig iron produced, and to note how this progress compares with that of some other countries in which the iron industry is of importance. The first reliable record of pig-iron manufacture in the United States shows a production in 1810 of 53,908 gross tons, the nearest contemporaneous data being for England in 1806,—243,851 gross tons,—and France in 1819,—112,000 metric tons.

In 1830 the United States is credited with 165,000 gross tons, England with 678,417 gross tons, and France with 266,000 metric tons.

In 1875 the United States produced 2,023,733 gross tons, England 6,365,462 gross tons, France 1,448,000 metric tons, Germany 2,029,389 metric tons, and Belgium 541,790 metric tons.

In 1892 the United States produced 9,157,000 gross tons, England 6,709,255 gross tons, France 2,057,258 metric tons, Germany 4,937,461 metric tons, and Belgium 753,790 metric tons.

Since 1854 the American Iron and Steel Association has collected and published accurate pig-iron statistics for the United States, and similar data are obtainable for nearly the same period for other countries; and, to illustrate the rapid strides made in the United States, and also the relation which this country bears to others which are important contributors to the world's output of this metal, the accompanying diagram has been prepared. It shows the quantities of pig iron made during the past 25 years in the United States, Great Britain, Germany (including the Grand Duchy of Luxemburg), and France, for as many of the years as authentic records are obtainable for in each case. The diagram needs no comment, for it represents the contemporaneous position of each of the countries named, and emphasizes the steps by which the United States have advanced to their pres-present position.

The story which it and the earlier statistics quoted tells is that a single blast-furnace of the average size of those now being constructed produces as much pig iron in a year as the entire output of the United States in 1810, and that two of the larger modern stacks can supply more metal annually than the country made in 1830. Approaching nearer to the present, a comparison may be found in the statement that in 1894 the 26 blast-furnaces in the vicinity of Pittsburg produced 1,782,079 gross tons of pig iron, which is about 90 per cent. of the total output credited to the nation in 1875, when there were 713 stacks reported in operation or in condition for work; and probably 350 of these stacks helped to make the total for 1875.

The history of pig-iron manufacture in the United States may, therefore, be considered as divided into three parts.

First. From 1645 to about 1840, when charcoal was the only fuel used; the furnaces, being deficient in power and supplied with cold blast, were restricted in size, and the consumption of fuel per ton of iron made ranged between 3000 and 5000 lbs. of charcoal. During that period the increased production was mainly the result of multiplying the number of furnaces, the difficulty of transportation restricting their location within convenient distances of a market for the product, and close to water power, woodlands, and ore mines. The furnace stacks were truncated pyramids of massive stone masonry, and from the tunnel-heads flames were constantly rising when the furnaces were in operation. Cinder flowed continually over the dam, while the molten iron accumulated in a fore hearth, from which it was tapped twice daily, or ladled out to form castings.

Second. From about 1840 to about 1870 the improvements in machine tools and the advance of steam engineering resulted in providing blowing machinery capable of operating larger furnaces, although many water-wheels were retained as power. The gases resulting from the furnace operation were utilized as fuel for boilers and to heat the blast in iron-pipe stoves; and bells fitting against hoppers in the furnace tunnel-heads gave control over these gases, and distributed the ore, fuel, and flux fed into the wider throats. Anthracite coal and bituminous coal, and coke made from the latter, were applied as blast-furnace fuels, and about 1854 the quantity of pig iron produced with mineral fuel exceeded that made with charcoal; after that date anthracite coal was the principal blast-furnace fuel for 20 years.

The stack structures passed through numerous changes in form, the present familiar type of an iron casing surrounding the furnace masonry and resting on iron columns being evolved from the massive stone stack through various modifications, in which brick displaced stone and iron supplanted brick. (It is of interest to note that the ground-spaces occupied by the stacks of the three furnaces illustrated on Plate I were practically the same.) The sandstone hearths and shale inwalls were displaced by linings of fire-brick, and the open tuyere and fore hearth were supplemented by closed tuyeres, tymp, and dam, all protected by water-cooling appliances.

With the introduction of steam, pneumatic, or water-balanced vertical hoists or inclined planes, it was not necessary to seek a location by the side of a bank level with the tunnel-head; and the increased transportation facilities by railroad and canal permitted the selection of sites where the raw materials could be conveniently assembled and the product readily carried to market.

This interval was characterized by enlarged furnaces, which supplied greater quantities of pig iron, and also by an increased number

of stacks; but, beyond the economy due to heated blast, there was no marked decrease in the quantity of fuel necessary to produce a ton of metal, the range being 2500 to 4000 lbs. From 1854 the quantity of pig iron made with anthracite coal was in excess of that made with bituminous coal and coke, but since 1875 the quantity of iron produced by the latter has been in advance of the output of the anthracite furnaces. Numerous modifications, due to the quantities of raw materials, pig iron, and cinder handled, were introduced, among them being intermittent cinder flushing, casting at shorter intervals, the use of charging scales, and receiving trestles for raw stock.

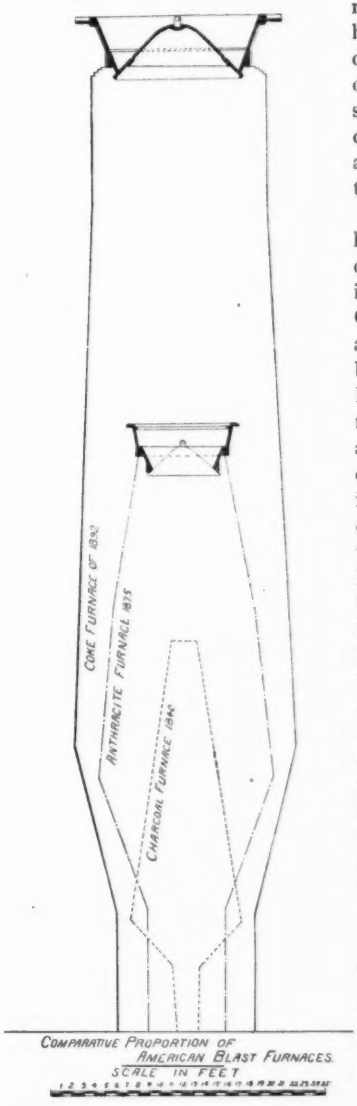
Third. Subsequent to 1870 came the radical development in blast-furnace practice, in which further increase in furnace dimensions was attained, still more powerful blowing machinery erected, and practice based upon a knowledge of the smelting process followed. The massive walls of fire-brick which prevented holding the furnace to an approximate interior shape desired were reduced in thickness and protected by water blocks, bosh coils and plates, crucible jackets, etc., so that now the quantity of fire-brick used to line the large coke furnace shown is probably no greater than was required for the smaller anthracite furnace on Plate 1. Iron-pipe hot-blast stoves were improved, and the regenerative fire-brick stove introduced, so that temperatures of 1200° and 1400° F. are employed in place of those ranging from 600° to 900°.

With larger crucibles supplied with highly-heated air under higher pressure, and the augmented space for reduction, greater quantities of iron are produced, demanding more frequent iron casts and cinder flushes,—the latter, and in some instances the former, being removed in a molten state in special ladle cars hauled by locomotives.

The chemist now analyzes the ores, fuel, and flux supplied to the furnace, as well as the iron, cinder, and gases which come from it, and the manager, with the knowledge of their composition to supplement his watchfulness of detail, is able not only to obtain increased output, but to furnish metal of a desired composition, the percentages of silicon, sulphur, phosphorus, manganese, and carbon being maintained within such narrow limits as to cause surprise to those who do not recognize the possibilities of blast-furnace practice.

With this increased yield and better control has come a marked decrease of fuel consumption, and the furnace which now requires the minimum amount credited to 1875 (2500 lbs.) is considered as working at a disadvantage, while records of 1750, 1800, and 1900 lbs. of coke used per ton of pig iron made are necessary to win praise at the present time.

The locomotive now takes the place of the horse or mule, and the



rock-breaker supplants the mine-hammer at blast-furnaces. The demand for iron of specific quality has necessitated careful selection and preparation of ores, fuel, and flux, and materials are now carried over long distances to blast-furnaces.

The three districts which have shown the greatest development in pig-iron manufacture in late years have Pittsburg, Chicago, and Birmingham, Ala., as their business centers. The bulk of the ore-supply for the Pittsburg district is brought from mines in Minnesota, Wisconsin, and Michigan to meet the local coke. The furnaces in the vicinity of Chicago also draw their ore from the Lake Superior district, the coke coming from Pennsylvania and West Virginia. Ore and coking coal abound in the Birmingham district, where iron is produced at low cost, but the metal made finds its greatest market in the States north of the Ohio and Potomac rivers. The assembling of raw materials from points so widely separated, or the carriage of iron made to distant markets, is only possible because of the economies introduced in blast-furnace operation.

The rapid growth of pig-iron production in the United States indicated on Plate II was not, as in previous divisions, due to an increased number of furnaces, for statistics show a nearly constant decrease in the number of stacks, the augmented output

coming from furnaces of larger average proportions and from improved practice. The number of blast-furnace stacks in existence at any time is subject to discount on account of plants being abandoned, destroyed, or out of repair, but fairly accurate comparisons can be made from the record of the number in blast at the end of each year. The following will indicate how the output per furnace has increased, the two columns showing the number of furnaces in blast in the United States at the close of the years stated and the total quantity of pig iron made during the year, as reported by the American Iron and Steel Association.

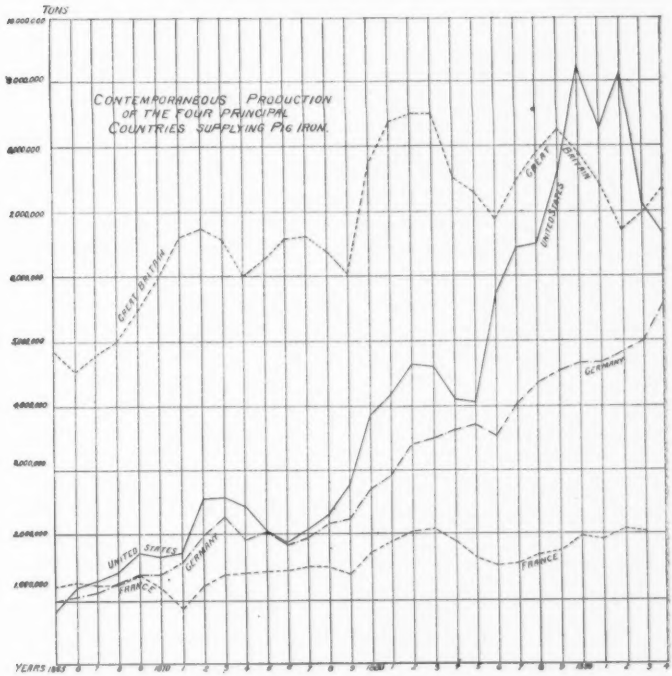
COMPARISON OF THE NUMBER OF FURNACES IN BLAST AT THE END OF EACH YEAR, AND TOTAL PRODUCTION OF PIG IRON IN THE UNITED STATES. 1873-1894.

Years.	Number furnaces in blast Dec. 31.	Production. Gross tons	Years.	Number furnaces in blast Dec. 31.	Production. Gross tons.
1873	410	2,560,963	1884	236	4,097,868
1874	365	2,401,262	1885	276	4,044,526
1875	293	2,023,733	1886	331	5,683,329
1876	236	1,868,961	1887	339	6,417,148
1877	270	2,066,594	1888	332	6,489,738
1878	265	2,301,215	1889	344	7,603,642
1879	388	2,741,853	1890	311	9,202,703
1880	446	3,835,191	1891	313	8,279,870
1881	455	4,144,254	1892	253	9,157,000
1882	417	4,623,323	1893	137	7,124,502
1883	307	4,595,510	1894	185	6,657,388

Comparisons based on this table will not be absolute, for the condition of blast-furnaces during each year is not reported; thus, towards the close of 1893, the production of pig iron rapidly fell off, and furnaces were blown out, while in 1894 the reverse occurred, the amount of metal increasing towards the close of the year. But the table indicates how great the advances have been, and this can be appreciated by considering that the mean between the figures for two successive years represents the average number of furnaces in blast during the year.

On this basis the table shows that the practice of 1880 was so much above that of 1873 that, with an apparent increase of but seven furnaces, the production was augmented 50 per cent.; similar comparisons indicate that, with a nearly equal number of furnaces reported in blast, the output for 1876 was more than doubled in 1884. This continuous growth in output is especially emphasized from the records of 1875, 1879, and 1892,—the latter year, with a smaller number of furnaces, having more than quadrupled the product of 1875.

Improved blast-furnace practice has, by augmented outputs and by reduction of the quantity of fuel, ore, and flux required per ton of pig iron, demanded less labor, and smaller amounts for repairs, fixed charges, etc., per ton of product; and this advance is well illustrated



in the declining selling prices of pig iron: for, as lower quotations cannot be met except by cheapening production, they really represent a progressive tendency as long as the reductions leave a fair return for labor and capital. From a statistical chart, prepared by Mr. Wm. G. Neilson, of the average price of pig iron from 1799 to 1844, supplemented by subsequent data collated by Mr. Jas. M. Swank, it appears that in 1799 charcoal pig iron was sold for $36.25 per gross ton in Philadelphia, and that the price, after various oscillations, had fallen to $32.75 in 1840. The statistics show that the price of No. 1 anthracite pig iron at Philadelphia was $25.75 per ton in 1844, rose during the war, then fell, and in 1875 averaged $25.50 per ton; while in 1890 it stood at $18.40, and in 1892 at $15.75, per ton. In the present depressed state of the iron market, prices have fallen still lower, the average in 1894 being but $12.66,—a rate evidently below that which indicates true progress.

The latter features of this decline will appear from the following *résumé* of average monthly quotations:

	January, 1892.	January, 1893	January. 1894.	January, 1895
No, 1 Anthracite pig iron at Phila.....	$17.50	$14.80	$13.37	$12.08
Grey forge pig iron at Phila.....	14.25	13.10	11.56	10.50
Grey forge pig iron at Pittsburg.....	13.50	12.30	9.88	9.17
Bessemer pig iron at Pittsburg.....	15.65	12.59	10.90	10.06

It has been possible only to summarize the prominent features of progress made, leaving many interesting details unnoticed; but this article would be incomplete if it failed to state that the results attained in iron-smelting have been made possible by advances even more pronounced in processes for converting the pig iron into manufactured forms, many of the researches into the chemistry of iron-smelting having resulted from the demands of steel and iron works for metal of special quality in large quantity. The marvellous changes in blast-furnace practice, the increased output per furnace, the low fuel consumption per ton of product, the restricted limit of composition attained, and the reduction in labor offer an excellent example of what can be expected in other branches of industry where technical investigation is supplemented by business methods and boldness of effort.

The proud record which has been but partially set forth in these pages represents close study, hard work, and liberal expenditure of money, and its history would embrace many failures and many discouragements. But the end is not yet; there are other investigations to be made, other difficulties to be overcome, and one cannot claim to speak prophetically who asserts that there are to be many more "advances in modern iron-smelting."

HINTS FOR THE MECHANIC AND EMPLOYER.

By Edwin Woodward.

INCIDENTALLY it is asserted that every one is adapted for some purpose. Nominally, this is undoubtedly true. But, while one man may be famed for his achievements in learning, another—perhaps his brother—may be noted for his development in cunning and depravity. There is nothing sensational in this statement; the occurrence is so common as to excite but little comment. However, it leads the thinker to ponder a little, and the question arises: Were these brothers born with opposite traits preponderating, and instinctively cropping out as years developed; or with similar characteristics has dissimilar training wrought the change? The question may never be answered satisfactorily. Still, every observer may have seen the winning child develop into the detestable man. No doubt he has also seen the ill-natured boy, by some marvelous transformation, become the kindliest companion. This would indicate that some force beside nature has influence in the matter. This marked difference in one family is suggestive. But, leaving the household, and taking humanity at large, there are an infinite number of individuals of all grades, running from the lowest up. It is not so difficult to perceive the use of the characters ranging from the middle up,—especially as they go up. Many good people cannot see the need of the individuals at the top,—those who cannot comprehend ordinary affairs of life, but can explain a theory with wonderful intuition. It goes without saying that the regard of these parties is mutual.

It is safe to assume that those of the lower scale are not wholly bad. In fact, one of the most dissolute characters known to the writer frequently exhibits evidence that the good is not all submerged. But the mis-spent lives of such persons are unerring guide-boards: Turn aside.

Between these two extremes and somewhere above the middle are a vast number of men—of all trades, no doubt, as well as professions, but surely among machinists and steam engineers—who are not successful, and the reasons are as various as their characteristics.

Many have noted the fact that, while a man may have very indifferent success in his trade, he may exhibit much shrewdness in other matters. This indicates either utter incapacity in that branch or a lack of earnest application,—generally the latter. The object in view, in the latter case, is to concentrate more of the energies on the labor; application is everything, if the ability is not wanting. But, if the

ability is not at hand, then there is prudence in forsaking this trade, no matter how congenial, and taking up some other occupation that will afford a possibility of success. In apprentice life this should not be done without careful inquiry. The youth himself is not a competent judge; the parents or guardians should look into the case, and the foreman may be able to give valuable information, if asked. If he is the right man in the right place, he will take especial note of the boy, if so requested.

These matters should be decided at an early stage, and, if the first choice is right, so much the better; indeed, it is very much the better, as a dangerous proclivity, an aimless shifting from one thing to another, is avoided. For the man in middle life there is not much to hope from such a change, unless he be more than ordinarily endowed with an aptitude for the new vocation.

Generally speaking, every one is arbiter of himself; success or failure lies within his own hands. Admitting the fact that outside causes largely influence matters, the fact still remains that these causes may be utilized, if for, or subdued, if against.

It may be repeated that to be successful requires something more than ordinary application. The outlines may be grasped by a comprehensive mind at a glance, but, as small matters constitute the great, so with the conception of the details goes the ultimate success. The young engineer readily masters the rudimentary principles of his trade. He knows that steam is produced by boiling water, and that safety depends on keeping the water-supply above the tubes; or, if he has never observed the relative height of the tubes and gage cocks, that there must, at least, be one gage of water. He learns, too, that steam must be admitted to the cylinder by the valve as the crank is passing the centre, and, further, that a liberal supply of coal will keep the steam up and a generous allowance of oil will keep things from heating, unless he happens to key the straps on the connection a little too tight, or screw down the journal caps too much; and then, if he has never given these things thought, he has ample time, before he gets the bearings running as nicely as before. But, if he were asked how much steam the boiler can safely carry, the fact would become patent at once that the figuring of the safe working pressure, or the data necessary for such figuring,—the strength of materials, stays, bracings, riveting, and details,—are matters of which he entertains extremely vague notions.

The same dense ignorance would be manifested, were he approached on the subject of the trimmings or adjuncts, the safety-valve, steam-gage, injector, and other parts. There is the same happy-go-lucky carelessness about the engine; set of the valve, lead-lap-compression, cushion

angular advance—clearance, angularity of rods, point of cut-off, and hundreds of other important things are neglected. This evidently is not the way to become a successful engineer in these exacting times. When anything goes wrong in the plant and the engineer in charge is not competent to right it, his time is up, if some one can be found capable of succeeding where he has failed. This should be an incentive to earnest study, which, coupled with practical experience, is the surest guarantee.

The same indifference to details observed in the engineers is also found in the machinist. He can select the proper lathe tool for iron, steel, or brass; knows the height to set it in order to cut best; can prevent chattering by a coarser or finer feed or a little more or less clearance; and is familiar with other points in every-day labor. But, if gears are to be arranged to cut a thread not shown by the index, the effort will require about half a pound of chalk, innumerable figures, and plenty of time, with no certainty of a satisfactory result. Width of key-ways extremely doubtful, pitch of threads the same, but "can easily find out by looking at the figures on the taps."

These things do not give the apprentice independence or decision; lacking either, he lacks much.

It is believed that everyone has, at times, a desire to get on with his work in a more thorough manner, and he resolves to seek further light. The impulse to resume his former study often springs up, and, if the proper encouragement is given at this moment, a happy result follows. Unfortunately the encouragement is not often given. Failures are not confined to those who cannot learn; many having a thorough knowledge of their business do not succeed. A knowledge of other things beside business is necessary. Honesty, integrity, business courtesy, and a host of moral virtues are essentials.

Then, too, it depends much on where one starts in for himself. Sometimes home is the place; more often it is not. Because a man has never made any special mark in his youth, a doubt is ever present as to his real knowledge. It is to be hoped that the writer will not be charged with advocating a tramping life, but certain it is that evil results often follow an attempt to build up a reputation in one's old home. The fact that one has, as yet, made no especial mark is, to most people of his acquaintance, evidence of incapacity. This conception of his ability prevents a recognition of his true worth,—often precludes any active proof of it.

The usual means of keeping him down are employed, prompted sometimes by doubt, sometimes by envy, till eventually the level of the average is the height of his ambition, and thus he merges from the man into the machine.

Very different is the result if his genius is permitted scope—as is usually the case among people unknown; their faith in him may be borne out by works, which alone bear testimony, either for or against.

Nothing is more true than the old edict: "A prophet has no honor in his own country"; for it is often noted that a stranger is given places of responsibility that could be filled better by some of our fellow-workmen.

Every one has observed that those quickest to learn do not always make the best mechanics. In fact, they seldom do. There seems to be a sort of fatality that the brightest learners are seldom able to shake off. It is the belief in their own ability to come out first. This is the natural result of early and easy success. Were the foreman wise, he would not flatter such a one. Rapid progress deludes the worker, and soon he thinks effort on his part unnecessary; when this opinion becomes deep-rooted, material progress ends. Two words from the foreman or employer at the right place work wonders,—one to check inordinate vanity, one to cheer despondency. Success is not a birth right; it is the fruit of labor. However, a fortunate train of circumstances may add largely to the degree of it. Many a young man is handicapped in the very beginning of his career by some unfortunate personal peculiarity. A "frank, open countenance," "an intelligent look," influences many people who know no other way to judge. Their general verdict in the case of those less favored is usually less gratifying. A gradual change is taking place in this respect, however,—due to the fact that customers leave orders at the office, and a competent workman is selected irrespective of his beauty.

It is frequently noted that a young man of a free, ingenuous, and hearty nature, from the very charm of his obliging disposition, seems the personification of success. No matter how unpleasant the task, it is taken in hand with the same cheerfulness that he displays when the work is especially agreeable. No matter how lavish of favors the foreman may be to him, he exhibits no disposition to exult over his less fortunate companions. For these reasons, while they may envy his "good luck," as they term it, it stirs up no vindictive feeling. Thus, one medium of success is cheerful good humor. There is another characteristic often seen, which every one desiring to get on well should be careful to avoid. It is that mean, cringing, fawning disposition that would seek to win favor by deprecating its own worth, or by attributing merits not possessed to those in charge over him.

A marked contrast to this is the sturdy independent nature that does duty, because it is duty; that does not care a rap for the foreman or any one else, so long as duty is conscientiously done. It is he that never courts any one's favor, is utterly indifferent to praise, and holds

flattery in contempt. It is often difficult to decide which is uppermost in the foreman's mind,—vexation at his indifference, or admiration for his independence; the latter eventually triumphs.

Follow the life of a boy from his school-days up. The youth with sleepy looks usually is very quiet, very awkward, and, as a rule, not much given to the sports which constitute the chief delight of his companions. He has consequently nothing in common with them. The boy observes this, feels hurt, and by repeated neglect becomes very sensitive, and thinks he is not treated as others are, when in truth he is as derelict as they. Having no other resource, he applies himself to his books, and usually makes more rapid progress than the rest. Eventually the indifference with which he is treated merges into respect, and this, coupled with acknowledged merit, would insure success, if some other boy did not happen to possess all of these and, in addition, that inexplicable something which attracts the good-will and esteem of every one, called personal magnetism. Parents are to a great extent responsible for the want of this characteristic.

The most indifferent may be taught to see that social intimacy between companions is productive of pleasure as well as mutual benefit; and, if the child is not endowed by nature with sociability, constant endeavor may stimulate the dormant faculties, and eventually make him one of the most agreeable and magnetic of men, just as earnest and faithful labor will make the best machinist or engineer from the most backward apprentice.

Many a man has mastered his trade—as it is said—and never perceived this truth,—plodding on, more soured by each new joke of which he is made the victim, becoming more despondent when some new abuse is heaped upon him, not knowing that by taking these and returning them he could work his own salvation. The case of a certain engineer in a large shop is brought to mind, as an illustration of this phase of life. He was faithful to his duties and employers, and in point of qualifications was no better or worse than the average. It did not take the boys long to discover that the poor fellow could not parry a joke or resent an abuse; as soon as one boy had fired his last shot, another would open his battery. He believed the boys when they told him he was to be discharged, and, thinking their talk reflected the sentiments of his employers, he gave up his job in fear of such a result. A little self-reliance would have tided him over.

There are other by-ways of failure and success. Another engineer is noted as overcoming difficulties. His start was a bad one, not only from a lack of theoretical and practical knowledge, but also from a lack of skill. All this was in a measure overcome, and in reality he may be classed as an ordinary engineer, conscientious and careful. These

two qualities, supported by public approval, are a trio invincible, and the secret of the latter is judicious diplomacy—nothing else.

How much is the foreman responsible for in the failure or success of his men? More than he is aware of, perhaps. It is his duty to study those under his care. Good will is beneficial, confidence helpful. Mutual esteem is the key of success. These are secured in various ways. It is said that an Irishman is vulnerable only to a joke, an Englishman or German to stiff-necked superiority, while an American approves of nothing but equality. Without doubt the joke has its place sometimes. It is manifestly true that certain men do not recognize any authority that is not tinged with dogmatic arrogance. While these aids may be judiciously used on occasion, they should not be adopted as a regular method of exercising influence.

No one who has not made it a study has any idea of the great number of first-class men occupying subordinate positions from feelings of sentiment or affection. It is quite impossible to induce a workman to acknowledge that such is the fact, but it is none the less true that scores of engineers and machinists are constantly refusing positions manifestly to their advantage, through no other motive. Family and social ties are minded. Unfortunately a certain class of people cannot appreciate such motives. But another and better class can and do. These tend to defeat the ascendency of any one whom these motives govern, and the loss is not his alone, or that of his prospective employer. The world at large suffers, for who will say that a character so admirable would not make an excellent chief engineer or foreman, and, by the display of the kindly traits with which he is so lavishly endowed, tend to elevate all with whom he comes in contact?

REVIEW OF THE INDUSTRIAL PRESS

WITH AN INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

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Asso. of Eng. of Cornell Univ. 1894. Ithaca.
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ARCHITECTURE & BUILDING

Competitive Designs a Failure.

THAT there is great and increasing dissatisfaction with the system of competition in designs is very apparent from the tone of the architectural press upon the subject. A strong editorial in *The Southern Architect* for April voices this discontent, and clearly shows that the system has been detrimental to the art.

On the contrary, notwithstanding the disfavor with which the profession regards the system, it is still much resorted to in the obtaining of designs by owners and building committees. "No one who is familiar with the practice of architecture in the south to-day can fail to see that 'competition' is rapidly becoming the usual method of selecting architectural designs. Several of the leading southern cities, those which have made the greatest advance in architecture, are notable exceptions to this. In fact, wherever there has been much attention paid to architecture by the people, competition has fallen into disfavor, experience having proven it to be generally a failure. But the present generation in the south has had neither time nor money to devote to architecture, is inexperienced in such matters, and has very naturally fallen into the error, which has had its day and passed in other sections.

"The application of the word 'competition' to this method of selecting designs is peculiarly unfortunate, since it conveys an idea very attractive to the man of business and yet wholly foreign to the meaning which is intended. It is difficult to find a word entirely suitable, but it strikes us that *contest* would be better than competition."

The inherent faults in the system are noticed in detail. One of the most serious is that competition precludes study of plans and designs on the ground, and "perfectly free consultations with all persons concerned throughout that study. This is impossible in a competition; few architects can spare either the time or the money to devote to such a concentrated study on a bare possibility of compensation, particularly when they reside at a long distance from the site of the proposed building. As a matter of fact, it is very rare that any design so submitted is a well-studied composition; and the successful architect seldom has the opportunity or inclination to revise his work. He finds himself tied down to a crude, ill-balanced design, and he can never so revise it as to overcome its conditions. In most cases no attempt is made to do so, but, the competition once won, the work is turned over to draftsmen to be developed, while the successful competitor turns his attention to the next competition. Thus even competent and conscientious architects find it impossible to accomplish their best work under such unfavorable circumstances."

The effort is thus reduced to an attempt to please the uncultivated taste of laymen whose knowledge of real architectural requirements, even regarding the necessary heating, ventilation, plumbing, and lighting, is often very small. The competing architects can therefore safely disregard these requirements, and thus produce designs the sole purpose of which is to be cheap and showy. "If sanitation interposes, as it often does, the health of the occupants of the building is sacrificed to some convenience of plan. Any and every requisite of good architecture is deliberately sacrificed, whenever necessary to secure a 'catchy' picture. By the use of water-color or a sketchy style, they slur over important detail, but make a pretty picture. They sacrifice all that is sound and good and pure for the mere picturesque. On the other hand, the competent and conscientious architect is handicapped in the race at the outset by those very qualities which are so necessary to protect the client's interest. He realizes at once the limitations imposed upon him by cost, by sound construction, by sanitary laws, by pure architecture, and he works constantly within

them. He produces an honest, practicable design and plan, which, from the very necessity of the case, does not compare in superficial attractiveness with that of his ignorant or unscrupulous competitor. And in nine cases out of ten it is turned down without the slightest consideration."

It is vain to rely upon reputation as a safeguard against the adoption of defective designs by incompetent building committees; and incompetence is the general characteristic of committees. "Many of the most important elements which go to make up a good building are the very ones not brought out in a competition, and, as a matter of fact, cannot be more than indicated." Neither hidden merits or hidden defects can be discovered except by such study as non-professional men are generally incapable of performing. "The motive for holding competitions is generally that the client does not know what he wants and is seeking for ideas from many sources. But how much better it would be to employ a competent architect to examine in his library reproductions of the best work in the world for suggestions as to style, have him sketch two or three different schemes for consideration, and entrust the rest of it to his superior knowledge of the subject. Instead of this, however, some unknown man, often a mere adventurer, is taken up upon no other recommendation than an attractive sketch,—for that is all that competitive plans ever are,—and, without the slightest safeguard, is entrusted with the expenditure of money, the complex problems of construction, the multitude of architectural details, both inside and outside, which go to make up the real excellence of every design, and the abstruse questions of sanitary science. In fact, on the strength of a mere sketch, which only indicates less than one-third of the essential features of the house, the other features are entrusted to a stranger."

There is, however, an argument for the competitive system, which must not be forgotten. The path to a successful practice is at best a rugged one for the young architect, and this system helps more to smooth it than any other could. It is true that prize competitions presided over by professional architects might better indicate real merit, but the competition that immediately opens the door to actual practice, and enables the beginner to set up a monument of his skill in the sight of all men, is an easier and quicker road to success.

Drawings and Specifications.

MORE work expended on drawings, with perhaps less on specifications, would, in the opinion of Mr. Bannister F. Fletcher, contribute to harmony between architects and contractors. In this utterance he has reference to what, in the title of a paper recently read before the Architectural Association, he calls "Specifications from an Architect's Point of View." The *Architect and Contract Reporter*, which prints this paper (April 5), also prints another by Mr. M. A. Holloway, entitled "Specifications from the Builder's Point of View." These papers may be conveniently reviewed together.

In the first place Mr. Fletcher contrasts recent specifications with those prepared 20 years ago, and finds that from brief documents they have gradually grown to voluminous and wordy ones, comprising matter that "serves only to perplex the clerk of works and worry the builder." A great deal of the extra length arises from the introduction of conditions of contract, which properly belong to the contract itself, and are in most cases entirely out of place in the specification. The function of a specification is wholly descriptive, and anything beyond this tends to confusion. "Do the wonderful little essays on how to lay drains, make terra cotta, mix cast-iron, test steel work or iron work, which we find in so many specifications, protect our clients, or help forward to any material extent the good and efficient workmanship and materials we all desire to see?"

"The system of splitting up a specification rigidly into trades has also much to answer for in introducing elements of confusion and difference. Each architect has his own view as to where a certain article should go, and, if he consistently follows out the trade system, what a number of references have to be made before you find

out all about a window, for example! On one page the sash and frame; on another, probably, the fastener and sash-lifts; on another the iron-tongue; on another the linings and architrave; elsewhere the glass; and so on. There are many of these cases where four or five references might be profitably put together, especially when you remember that the practice of allocating the items under trade headings differs considerably. For instance, tile pavings and wall-linings get put into the bricklayer's specification by some, the mason's by others, and the plasterer's by others. Then the concrete bed for the tile-pavings and rubbish thereunder, and the cement surface on which the tiles are to be laid, get into different sections, and so in a simple tile-floor we may have to make four or five references before we get it complete. The phraseology of the modern specification also leaves much to be desired, especially in the constant use of words defining quality. The words 'best,' 'very best,' 'proper,' 'perfect,' &c., are all relative terms of quality, which frequently are quite differently interpreted by the architect and builder, the one using the word in the ordinary sense, and the other in the manufacturer's sense. It is no uncommon thing to find in a trade catalogue the expression 'extra super best,' as meaning something superior to that described as 'best'; and, although it seems absurd to encourage such superlatives, if you want the best, you have to go beyond the ordinary English meaning of the word, and accept the grandiloquent language of the catalogues. The word 'proper' is a frequent stumbling-block, and its use should be discouraged as much as possible, especially in the sense in which we find it,—as, for instance, 'fir proper door frames.' These relative terms of quality should be quite abolished, and the definite expressions of the manufacturers used instead; and by so doing we shall, as regards materials at all events, have a common basis of agreement with the builder. At present quality is left too much to the imagination, and is only implied when it can and should be stated in exact terms."

Discrepancies between specifications and drawings are also a frequent cause of trouble. "In the great majority of cases this arises from the habit of writing a specification and using an old one as a model, and so we get materials specified which the architect does not intend to use, and, when the work is being carried out, points of difference arise. If quantities are supplied, the surveyor can easily adjust the variations in description; but, assuming their absence, each person tendering puts his own construction upon the clause, with the inevitable result that, whichever way the architect wants the work done, an 'extra' ensues. Of course, there are builders and builders, and the architect has to be prepared for the worst type in these days of close competition."

There should be more work put on the small scale drawings in order to avoid minute description in the specifications. "Specifications go out of their true course when they cease to be anything more than descriptions of materials. It seems to me that the necessary documents or instruments of a contract should be, first, the plans, elevations, sections, and detail drawings; second, the description of the materials to be used, which of necessity must be a written document,—for convenience called the specification; third, the conditions of contract, or legal restraints by which you bind the builder to do the work in accordance with the plans and specification, and also bind the employer to pay for the work done." The drawings may be so clear, detailed, and annotated as to render a specification almost superfluous. Of course this means a greater expenditure of time and labor in the architect's office, but it is thought that this would be compensated by the avoidance of difficulties and extras that otherwise come in during the erection of buildings.

Mr. Holloway's paper enumerates the difficulties which builders experience in working from modern specifications. In the main it supports the points made by Mr. Fletcher, but it adds the belief that even with well-prepared drawings and specifications, unless there be mutual confidence between architect and builder, difficulties will inevitably arise.

The Value of Sentiment.

A MOST powerful argument against the modern vandalism that reverences nothing old, and eagerly replaces remarkable structures, around which cluster historical associations, with uninteresting, commonplace modern buildings, was delivered by Col. Lee at a meeting recently held in Boston to consider the advisability of demolishing the old State House. An ambitious new State House has been built behind the old one in Boston, and seven times as large as the old one; and it seems that even in Boston, which claims to be the center of American culture, there is a party in favor of tearing down the old structure. Speaking of the associations connected with the old building, Col. Lee said there had been thirty-five governors of Massachusetts since the old building had been erected, and they had all been good governors. Governor Long, one of the thirty-five, in a previous speech had seemed to think there was no history of importance connected with the old building; but he was reminded that the first century of the existence of Massachusetts had a very interesting history. The war of 1812, in which Boston suffered severely, and the victories of that war were recalled. Through the streets of Boston, and up to the old State House, had marched Hull and Dacre to pay their respects to the governor. In the dome the women of Boston stood, with anxious eyes and hearts, to witness the terrible naval battle between the *Chesapeake* and *Shannon*. Many distinguished visitors, among them Lafayette, have been received and honored there. The great civil war was historically associated with the State House. In speaking of the events of that memorable struggle, Col. Lee became eloquent.

"There was something done in the house in those long, fearful years of agony and weariness, heart-breaking disappointment and losses; the procession of young men coming to offer themselves for service, saluting the governor, like the gladiators the Emperor, 'We, who are about to die, salute you.' Do you suppose there is no feeling connected with these rooms where the governor sat for those four years?—a man of peace called upon suddenly to prepare this State for a fearful war, and preparing it in spite of ridicule, in spite of denunciation, and preparing it so promptly that Massachusetts was the first State; the first men who were sent properly equipped and armed for the war were the men of Massachusetts. The whole world wept for Lincoln's death; are there no tears for Andrew, who fell after the war, as much as Lincoln? He was killed by an assassin, but, if he had not been, he would have died in a short time from head and heart weariness. Do you suppose Governor Andrew could have sat here those four years, night and day,—for he was here much of the time night and day working and enduring, and feeling that he had been, more or less, instrumental in bringing about the deaths of all the flower of Massachusetts,—without any emotions? Was there no association? You have the association of Bunker Hill—for what? A battle of four hours. Has a battle of four years no association for this building—the agony of those four years? Men, haggard with anxiety and grief, and the mourners going about the streets from every house: Rachel weeping for her children, and not to be comforted because they were not. Is there no association for this building, where the headquarters of the whole government of the time were? It seems to me absurd. I should like to read a small sentence from William Morris, on this subject: 'If we are not prepared to put up with a little inconvenience in our lifetime for the sake of preserving a monument of art which will elevate and educate, not only ourselves, but our sons and our sons' sons, it is vain and idle for us to talk about art, or education either. Brutality must be bred out of such brutality.'"

About monuments, the speaker, in an earlier part of the address, said: "A monument—what is a monument? There were some rich men that thought a monument ought to be something new; they had Mr. Cook's idea about it, that it ought to be something new, something in the present style—I don't know whether the dome of St. Peter's had been changed

to the present style to attract people, or not. They thought this monument ought to be something new, something pretty fine. When my father took me over to see Bunker Hill, there were the earth-works; one could see the redoubt on which Prescott stood; see the breast-work; see where the rail-fence ran. One could see all the way down to the Navy yard, to Moulton's Point, where the British landed. There was something like a monument; it was not a mere record which the monument afterwards was; it was a reminder of the scene, and that is what a monument should be. You stood there, and all the sentiment of the battle came to you. Now you go there, and you stand upon a hill, nicely graded and all the redoubt and breast-work filled up and erased, and you have the pleasure of seeing an Egyptian obelisk. Well, it is a matter of taste: to me the old earth-works would have been more inspiring, more suggestive, without the Egyptian obelisk."

The Tarrant Building, New York.

THERE are peculiar features of construction in this building, designed to meet special requirements, which render an illustrated and detailed description of them by the architect, Mr. Henry Rutgers Marshall, in *The Engineering Record* (April 15), a good engineering and architectural study. This building, situated on the corner of Warren and Greenwich streets, was erected under contract stipulations in the short space of 4¼ months. "This rapidity of construction made great watchfulness necessary, and led to the adoption of some special devices to avoid risks of unequal settlement, and danger of delay in consequence of faults or imperfections in materials, which devices may be of interest to constructors quite apart from any interest that may attach to the spirit of the design."

"The floor loads had to be calculated to resist large and irregular strains, the maxima being for first floor, 420 lbs. per sq. ft.; second floor, 220 lbs. per sq. ft.; third and fourth floor, 320 lbs. per sq. ft.; fifth, sixth, and seventh floors, 220 lbs. per sq. ft. These maximum strains were unlikely to be realized at more than a few points in the building at any one time; and there was great danger of irregular settlement within the boundary walls."

It was therefore decided "to construct the walls so that they would stand entirely independent of the floors, which latter were carried on an independent system of posts and girders. It was necessary to make the posts of cast iron, instead of wrought iron as I should have preferred, in order to avoid delays. That there might be as little danger as possible of imperfections in the columns due to irregular contraction around the brackets holding the girders, I decided to adopt, on the large columns, a system of annual corbel brackets, which were slid over the columns after the latter were placed in position, these brackets having their bearing upon annular lugs cast on the body of the columns. It was thus possible to cast these corbel brackets of a very unusual size and strength, and thus to reduce, to a great extent, the size of the girders. For these girders I was thus able to use hard pine in almost all cases. This use of pine is preferable, in my opinion, to the use of iron for girders in a building of this character, where sudden hot fires may occur, and where, in consequence of the illiberal terms offered by the insurance companies, it is impossible to show investors that thoroughly fireproof construction will be economical for them.

"The flanges, where the columns were bolted together, were cast a little above and below the bearing surface of the columns, so that there could be no danger of the bearing coming upon these flanges (which are not calculated to stand such strains), as must often happen if the flanges are cast flush with the column ends, when there is inaccuracy in the bearing surfaces.

"The difficulties as to irregular settlement of the floor-weight system were met as follows. The wall columns were anchored to the the walls by bar anchors, playing in slotted lugs cast on the columns. The ground on which the building was to stand was explored by a sand pump and found to consist of fine sand throughout the greatest depth examined. The upper strata proved to be quicksand; and, in or-

der to avoid delay and expense, the foundations were placed as close as possible to the highest permanent water level. The foundations of the column system were carefully calculated to sustain probable pressures which they would be called upon to bear. But, as there was a probability that they might be liable at times to sustain heavier pressures in certain parts than those calculated for, I deemed it wise to attempt a separation of the foundations of the walls, which are not subject to change of weight, from the foundations of the columns against the walls, which are subject to change of pressure. To this end, I carried these column foundations at right angles to the walls against which they abutted. The wall pressures were transferred by arches over these column foundations. Thus, and by a system of inverted arches used on the street wall, the column pressures and wall pressures were brought to bear upon entirely different bodies of the underlying sand."

As already intimated, the detailed drawings of the construction, which cannot be here reproduced, aid much in gaining a clear comprehension of the description. The third- and fifth-story floors are made water-tight, and provided with drain pipes, which, in case of fire, will carry the water off into a court. This protects floors below from damage by water, in case of fire in an upper part of the building. This building has now been occupied for two years with extreme variations of load and temperature in different parts of the structure, and it is asserted that it has met these conditions "without the least sign of injury through settlement."

REMOVING putty from old sashes is not so easy a job as would at first sight appear. It is almost impossible to cut the putty out with the usual hacking knife and hammer without damaging the woodwork. To avoid these inconveniences, and the danger of accidents to clothing and hands when strong acids are used, a good plan is to employ petroleum—three successive coatings of petroleum, at intervals of half-an-hour, generally being all that is required. It may be stated as a reason for this that petroleum penetrates into the pores of the putty and dissolves the hardened linseed oil. In a short time the putty regains its original plasticity, so that in two or three hours after the application of the first coat one can, with the point of a knife, cut out the putty with ease.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Architecture and Building in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

*30895. Architecture in Colombia, South America. Ill. C. F. Z. Caracristi (Stone-April,) 900 w.

*30922. Competitions. Editorial (So Arch-April.) 2200 w.

*30923. The Profession of Architecture. William M. Rose, in Kansas City Arch. & Builder (So Arch-April.) 1200 w.

*30934. Specifications from an Architect's Point of View. Mr. Pinks (*Arch*-April 5.) 4000 w.

*30935. Specifications from a Builder's Point of View. A. Holloway (*Arch*-April 5.) 3000 w.

*30936. Architects and Quantities (*Brit Arch*-April 5.) 2500 w.

30950. Constructional Features in the Tarrant Building. Ill. (Eng Rec-April 13.) 1500 w.

30952. On the Application of Color to Architecture. A. T. Sibbald (Am Arch-April 13.) 3500 w.

30953. The Relation of Architect and Client. T. M. Clark (Am Arch-April 13.) 4500 w.

*30963. The Bristol High Cross, Stourhead, Wilts. Ill. (*Builder*-April 6.) 800 w.

*30964. Netley Abbey (*Builder*-April 6.) 2000 w.

*30992. The Early Christian Architecture of Rome. William P. P. Longfellow (Arch Rec-April June.) 6300 w.

*30993. Decorative Art. Candace Wheeler (Arch Rec-April-June.) 2600 w.

*30994. The Colonial Buildings of Rensselaerwyck. Ill. Marcus T. Reynolds (Arch Rec-April-June.) 9200 w.

*30995. A Discovery of Greek Horizontal Curves in the Maison Carrée at Nimes. Ill. William H. Goodyear (Arch Rec-April-June.) 7500 w.

*30997. Architectural Aberrations. — The Cairo. Ill. (Arch Rec-April-June.) 1800 w.

31072. Code of Practice for Sub-Estimating and Sub-Contracting. — Adopted by Master Builders' Association of Boston (Am Arch-April 20.) 1000 w.

We supply copies of these articles. See introductory.

*31081. The Application of Color to Architecture. G. F. Stalker (Can Arch-April.) 1000 w.

*31118. "Architect and Builder." Editorial (*Brit Arch*-April 12.) 1400 w.

31141. The Wind Pressure in Tall Buildings of Skeleton Construction. Ill. W. L. B Jenney (Eng Rec-April 20) 1600 w.

*31151. The Use of Steel in Large Buildings. Ill. Corydon T. Purdy (Jour Asso Eng Soc-March.) 13000 w.

*31155. Regulations Governing the Erection of Buildings, Applicable to Cities Having a Population of from 10,000 to 30,000. Ill. Compiled by the Asso. of Eng. of Virginia (Jour Asso Eng Soc-March.) 5500 w.

31240. Report of the Condition of the Massachusetts State-House (Am Arch-April 27.) 2000 w.

31241. Exhibition of Architectural Drawings in Boston (Am Arch-April 27.) 2000 w.

*31261. The Fugger and the Schnekin Chapels at Augsburg. Ill. H. W. B. (*Builder*-April 20.) 1800 w.

*31318. Color in Brick and Terra-Cotta Architecture. George M. Fiske (Br Build-April.) 1400 w.

†31349. The New Government House, Rangoon. Editorial (*Ind Engng*-March 23.) 1200 w.

*31355. Floors and Floor Cloth (*Ill Car & Build*-April 19.) 1200 w.

*31356. Domes (*Ill Car & Build*-April 19.) 1800 w.

*31359. Our Cathedrals and Abbeys. Ill. J. Edwin Forbes (*Ill Car & Build*-April 19.) 7000 w.

*31360. Cottages, Ancient and Modern. From Building News (*Ill Car & Build*-April 19.) 1800 w.

31389. The New York Herald Establishment. Ill. (Sci Amer-May 4.) 1200 w.

31391. Silver Gray Roofing Tile (Sci Am Sup-May 4.) 3000 w.

31453. Architects' License Bill as Last Agreed Upon by the Assembly. Also a History of the Bill, by William J. Fryer (Arch & Build-May 4.) 3500 w.

31468. The Ellerslie Cow Barns. Ill. (Eng Rec-May 4.) 1800 w.

†31483. The Bread-and-Butter Side of Architecture. C. H. Blackall (Tech-No. 9.) 2800 w

*31529. Housing the People in London and the Provinces. (Abstract.) Henry Lovegrove (*Arch*-April 26.) 1600 w.

*31540. Rational Building (*Builder*-April 27.) 2200 w.

*31542. North British Railway Hotel and Offices, Edinburgh.—Report on Design by John Burnet, Son and Campbell. Ill. (*Brit Arch*-April 26.) 4000 w.

*31563. A Norwegian House. A. S. T. (*Ill Car & Build*-April 26.) 1600 w.

Serials

18857. Electrical Science for Architects. Ill. Russell Robb (Am Arch-Began Jan. 13, 1894—10 parts to date—15 cts. each).

19078. Problems in Stone-Cutting. Ill. Ed. W. Hind (Stone-Began Jan. 1894—13 parts to date—30 cts. each).

19218. Manhattan Life Insurance Building. Ill. (Eng Rec-Began Jan. 20—7 parts to date 15 cts. each).

19713. Brick and Marble in the Middle Ages. Ill. G. Edmund Street (Br Build-Began Jan. 1894—16 parts to date—30 cts. each).

20419. Modern Methods of House Painting. A Ashmun Kelly (*Plumb & Dec*-Began March, 1894—13 parts to date—30 cts. each).

21288. Theatres. Ill. E. A. E. Woodrow (Am Arch-Began April 14, 1894—15 parts to date—15 cts. each).

21736. The Art of Building Among the Romans. Ill. Auguste Choisy. Translated by Arthur J. Dillon (Br Build-Began April, 1894—12 parts to date—30 cts. each).

26069. Modern Steel Fire-Proof Construction. Ill. F. M. Small (Arch & Bldg-Began Oct. 13, 1894—6 parts to date—15 cts. each).

26070. The Planning and Construction of American Theatres. Ill William H. Birkmire (Arch & Bldg-Began Oct. 13, 1894—7 parts to date—15 cts. each).

26967. Stained Glass and Fret Lead Windows, etc. Ill. W. J. Eden Crane (*Ill Car & Build*-Began Nov. 9, 1894—8 parts to date—30 cts. each).

27036. The Basilica and Its Adaptation to Modern City Churches. Ill. George Ashdown Audsley (Arch & Bldg-Began Nov. 24, 1894—6 parts to date—15 cts. each).

27954. The Musical Ideals of Architecture. H. Toler Booraem (Arch Rec-Began Jan.-March—2 parts to date—30 cts. each).

28494. Bricks and Terra Cotta (*Builder*-Began Jan. 5—15 parts to date—30 cts. each).

29253. The Guilds of the Medieval Workers in Stone. Edward C. Weaver (Stone-Began Feb.—3 parts to date—30 cts. each).

30491. Various Systems of Concrete Construction. Ill. Ross F. Tucker (Br Build-Began March—2 parts to date—30 cts. each).

30812. The "Sky Scraper." F. C. Gordon (*Ill Car & Build*-Began March 29—2 parts to date—30 cts. each).

30959. Building Contracts Arnold Statham (*Ill Car & Build*-Began April 5—Ended April 11—2 parts—30 cts. each).

30996. Lineal Perspective. Ill. G. A. Middleton (Arch Rec—Began April-June—1 part to date—30 cts).

30998. The Alphabet of Architecture. Ill. Harry W. Desmond (Arch Rec-Began April-June—1 part to date—30 cts).

31085. Notes on the Polychromatic Decoration of Churches. George Ashdown Audsley (Arch & Bldg-Began April 20—2 parts to date—15 cts. each).

31319. The Modern Office Building. J. Hollis Wells (Br Build-Began April—1 part to date—30 cts).

We supply copies of these articles. See introductory

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal Engineering."

The Shrinking and Swelling of Excavated Material.

THE measurement of excavated material has probably been one of the most fruitful sources of disagreement and dispute between engineers and contractors. A prominent example of this has been furnished in the harbor works at Quebec. Introducing a paper under the above title by a brief reference to the suits and countersuits bearing on the question of allowances to contractors by engineers in charge of these improvements for what may be termed the swelling or expansion of excavated material as compared with the space it occupies *in situ*, Mr. Charles Baillairge, C. E., Quebec, in *The Canadian Engineer*, discusses the subject.

The motive of the paper is "to enlighten the profession and invite argumentation on a technical, important, and very much disputed subject." Mr. Baillairge asserts that "very few authors allude to the subject in any way, and few or no experiments have been made to ascertain and tabulate the ratios and their time-varying values."

"Trautiome has it, under the heading, not of expansion, but of 'Shrinking of Embankment,' that, 'although earth, when first dug and loosely thrown out, swells about one-fifth part, so that a cu. yd. in place averages about 1.2 cu. yds. when dug, or 1 cu. yd. dug is equal to 5/6 or 0.833 of a cu. yd. in place, yet, when made into embankments, it gradually subsides, settles, or shrinks into a less bulk than it occupied before being dug.' The following are shrinkages taken from Trautiome: gravel or sand, about 8 per cent., or 1 in 12 1/2 less; clay or sand, about 10 per cent., or 1 in 10 less; loam, about 12 per cent., or 1 in 8 1/3 less; loose vegetable surface soil, about 15 per cent., or 1 in 6 2/3 less; puddled clay, about 25 per cent., or 1 in 4 less."

Mr. Baillairge has substantiated these statements for a solid yard of stone reduced to road metal, but not for the other materials; and there seems to be a chance here for good experimental work in some of the technical schools, which could, after a time, furnish tabulated statements that would be authoritative. The experimental work done in these schools is not the least of their public benefits.

"Now, while common earth or dirt, when freshly excavated, may swell some 20 per cent., or one-fifth, as Trautiome says, such is not the case with sand of the description dredged on the site of the Quebec harbor works; nor has the writer upon trial found it to expand or occupy in the loose a bulk greater by more than 5 per cent. than in the solid or *in situ*; and from experiments purposely made from successive heights by the writer, and on which to base his testimony as given in the exchequer court in one of the suits alluded to, he found that the sand, as excavated and handed up by the dipper and then dumped into the scow, did fall just with such a thud or force or weight of impact as to consolidate it or cause it to enter into exactly the same space as it occupied *in situ* in the bed of the river, and that consequently the contractors could claim no allowance for expansion on material of the kind."

"Many apparently plausible arguments were adduced to shake the faith of the court in the premises,—that is, in the result arrived at by the experimental work of Mr. Steckel on some 1,500 yds. of the material, as already stated,—such as the fact of the out or overflowing water from the surface carrying with it a heavy percentage of the stuff; and so it would, had it been mud or sludge instead of sand; as if the court were blind enough not to see that, even if the assertion were true, it would be no argument anent the correctness of the result arrived at, since the stuff, if any, falling overboard, would flow or fall back into the excavation, and be scooped or dipped up and again find its way into the scow."

One of the contractors showed that measurement in the scow "ran short of the measurement *in situ*," owing to the fact that some of the material was washed away when loosened, the current in such cases doing a part of the work for which the contractor was paid. A distinction is made between allowances due to the fact that excavation cannot be "confined to the exact figure of the section," and the expansion due to the swelling of the material. The tendency of contractors to overdo their work "when paid by the yard," particularly if the rate at which they are paid is found to be profitable, is also one of the facts of engineering experience. Cases of refilling also occur. If excavation material be frozen, it may be "loosened and swollen" before it is excavated. The effect of the presence of worms and of foraminifera, is also noted. This is illustrated by the structure of ant-hills. Common earth may swell when excavated, and then become again compacted by the filling up of interspaces. This is illustrated by the settling of oats or other grains of elongated forms when a receptacle containing them is shaken. On the whole, there is outlined in this paper a subject of great interest and importance, which we hope will be followed by systematic experimental investigation.

Prevention of Ice at Intakes.

THE past winter was prolific of trouble from ice obstructions which in many cases threatened the continuity of water-supplies, and in some cases caused great inconvenience by lessening or stopping flow through pipes. English people suffered much from this cause, the cold having been unusually severe in many districts. More than ordinary embarrassment of industries using water power resulted from anchor ice. The prevention of such obstructions has been made the subject of renewed thought and discussion in engineering societies. The different means employed in various places for prevention of ice obstructions at intakes are stated in *The Engineering Record* (April 27) in an abstract of a report of Mr. Edward B. Guthrie, assistant chief engineer of the department of public works, Buffalo, who has been inspecting "the water tunnels of Chicago, Milwaukee, Cleveland, and Erie, with a special view of learning what methods were adopted to keep them free from ice." At Chicago the ice is combated in several ways. One of the cribs at that city is situated 2 miles out in the lake. When Mr. Guthrie visited it, "the temperature was at zero and the conditions favorable for examining the method of keeping away ice. The 2-mile crib is pentagonal and measures 58 ft. on each side. It incloses a well 22 ft. on each side, with two shafts and four ports, each 4 ft. high and 5 ft. wide. Surrounding the crib at a distance of 30 ft., except for an open space of 30 ft., is a breakwater, forming a channel in which the water passes from the lake to the ports. On the day of the visit there was a tug with its stern in the opening of the break water, and men were poling ice into the outward current created by the propeller, so as to keep the channel into the lake free from ice. A large timber beam had been placed across the opening in an unsuccessful attempt to keep out floating ice. The main difficulties lay in keeping the channel between the breakwater and crib free from floating and slush ice, and the ports free from slush and anchor ice. Chains are laid through the ports, and are dragged back and forth to keep them clear. Moreover, three of the ports are provided with iron pipes slung vertically outside. The lower ends of these pipes are bent at right angles and drawn down to form a nozzle of smaller diameter. There are two steam pumps on the crib, from each of which a hose is carried to the upper ends of the pipes and water forced through them at 140 lbs. pressure. These streams are directed to all sides of the ports, thus forcing the ice into the well, where some of it is scooped up by nets or wire baskets, the greater part finding its way, however, into the tunnel. The water in the well was in a continual swirl, showing the rapid draft into the tunnels."

At the 4-mile crib, as it is called, at Chicago, little trouble has been experienced. "The surface of the water in the well shows little or no agitation. The only

provision for combating ice consists of wire baskets to scoop it up; these are hoisted by a steam engine to an overhead trolley, by which they are run out to the side of the crib and discharged into the lake."

At Milwaukee, where 24,000,000 gallons are pumped daily, the intake is about 1200 ft. off shore and consists of the turned-up end of a pipe 3 ft. in diameter, protected by piles driven around it. Here "there was trouble for a time with anchor ice, and a 50 h.-p. boiler was set up, and connected by a 2-in. steam pipe with the inside of the intake. When ice begins to form at the inlet, steam is turned on, and the trouble ceases in 15 minutes. A brick-lined tunnel 7½ ft. in diameter is now under way at a depth of 140 ft., which is to terminate at a twelve-sided crib measuring 56 ft. in outside dimensions and provided with four ports 5 ft. wide and 3½ ft. high for emergency use. From the crib two parallel 5-ft. cast-iron pipes are laid in a dredged channel to a point 5000 ft. further out, where the water is 60 ft. deep. Here the ordinary supply of water will be taken through a submerged intake, consisting of a crib about 10 ft. high surrounding the upturned ends of the pipe. On the top of this crib is a timber grating with openings 2 in. wide and a total combined open area several times larger than the area of the pipes."

At Cleveland the water is taken from the lake through two brick-lined tunnels, the intakes being 9000 ft. off shore. A single pentagonal crib, 54 ft. on each side, 60 ft. high, and submerged to a depth of 38 ft. has a well with "sides 19 ft. long, in which there is a 10-ft. shaft running down to the 5-ft. tunnel, the shaft to the 7-ft. tunnel being located in one of the pockets of the crib.

"There are three ports leading to the well, each 5 ft. wide and 2½ ft. high, with sills 24 ft. below the surface of the water. The ports of the shaft in the pocket are five in number, each 3 ft. square and cut through the outer wall of the crib at various levels. Originally the 10-ft. shaft inside the well had a wooden cap, leaving a space between it and the top of the shaft. This space became stopped with ice, and caused so much trouble that the cap was removed, since which time there has been little or no difficulty." Mr. Guthrie has arrived at the conclusion "that, if water could be drawn at a sufficient depth through a sufficiently large area and the inflowing current reduced to a few inches a second, there would be little or no trouble from ice. Acting upon this theory, the submerged intake constructed about as described above for Milwaukee has been devised; this type has been in successful use in Toronto." The tendency since the first of these cribs was built at Chicago 30 years ago has been toward larger ports and slower velocity of in-take, and experience confirms the wisdom of this modification.

River and Harbor Improvement in the United States.

A PAPER, largely historical, by Mr. L. Y. Schermerhorn, C. E., is a feature of *The Journal of the Franklin Institute* for April. It points out that the articles of confederation (1777 to 1789) conferred upon congress "no power over commerce or navigation . . . . Each State enacted such laws as it pleased. Rivalries existed whereby one State competed with another: one, by more favorable navigation laws, sought to increase its own trade and commercial advantage at the expense of sister States." At the time our national constitution was adopted the States were unanimous in the opinion that power to regulate commerce should be supremely vested in the congress. Certain taxes levied by the States were, however, continued by consent of the general government, and acts of this kind were continued down to 1828. The first appropriation made by congress for improvement of water ways was in 1802, when $30,000 was voted "for the erection of piers in the river Delaware." "In 1841 congress provided that to each new State thereafter admitted to the Union 500,000 acres of public land should be set aside, the proceeds of the sale of which was to be faithfully applied by the State to the building of bridges and the improvement of roads, canals, and watercourses, over which the United States should have the right to transport, free of toll, its mails, troops, and

munitions of war." During the interval between 1838 and 1866 only "three regular river and harbor bills were passed." A few small appropriations for local purposes—mainly repairs of works already built—were made. From 1866 to 1882 "annual river and harbor bills were passed, usually in annually increasing amounts. Up to 1870 the total of appropriations for such improvements was $31,648,600. Up to 1894 the total is $262,845,900. It is thus seen that during the last 24 years the appropriations have been $231,147,300, or an average of nearly $10,000,000 a year.

"The planning and execution of these works of river and harbor improvement is a part of the duty of the corps of engineers of the army, which is practically a bureau of the war department, of which the secretary of war is the head. In this work the entire country is divided into five divisions,—*viz.*, the Pacific, Northwest, Southwest, Northeast, and Southwest; and over each is placed one of the senior officers of the corps, usually with the rank of colonel, in the capacity of supervising engineer. These five divisions are further sub-divided into from forty-five to fifty districts, each in charge of an officer of the corps, and generally known as the local engineer-in-charge of river and harbor improvement. The official head of the corps is the chief of engineers, with the rank of brigadier general. Plans and projects for improvements, with estimates of cost, and also all reports upon examinations or surveys called for by congress, are submitted by the local engineer of each district to the supervising engineer of the division, by whom they are transmitted to the chief of engineers, with such comment as, in the judgment of the supervising engineer, may be necessary. At least once in each year the supervising engineer visits each district in his division, and, accompanied by the local engineer-in-charge, makes a careful inspection of all works in progress. Upon the works of river and harbor improvement there are now engaged, exclusive of the chief of engineers, about 77 officers, with the following rank,—*viz.*, 6 colonels, 9 lieutenant-colonels, 15 majors, 18 captains, 21 first lieutenants, and 8 second lieutenants. The second lieutenants of the corps, after being graduated from a 4 years' course at West Point, are assigned to a post-graduate course of 3 years at Willett's Point. This course is essentially a school of practice under the tuition of officers of the corps, in which the young engineer is taught to coördinate his theoretical knowledge with its practical application to the arts of fortification, defences, and river and harbor improvements. As a further preparation for active practice, he is often subsequently assigned to duty under a senior officer as an assistant upon constructive works, thereby passing through a novitiate which well prepares him for the active practice of his profession."

"The administration of the works of river and harbor improvement requires the employment of large numbers of civilians, in the capacity of assistant engineers, surveyors, and draftsmen; and a large body of men has been drawn from the engineers of the country to fill these positions. To supply increasing demand for such services, nearly all our engineers have introduced into their courses instruction relating to river and harbor improvement."

Preservation of Iron Structures Exposed to Weather.

DOUBT having arisen that coatings of iron oxid paint applied to iron structures were effective in preventing the formation of rust underneath the coatings, M. E. Gerber, C. E., was commissioned to make an examination of a number of large structures to which this kind of paint had been applied, and to report upon the condition of the paint and of the metal under it. The following bridges and structures were examined. "The bridges at Cairo (Ill.), Memphis, Merchants, at St. Louis, Bellefontaine (near St. Louis), Leavenworth, Rulo (Neb.), Nebraska City, Plattsmouth, Union Pacific Ry. Bridge, Omaha and Blair (Neb.), Sioux City, and Alton (Ill.), all painted with one kind of pure iron oxid paint, mixed with pure linseed oil. The drawbridge at Omaha, the lower bridge at Winona (Minn.), the union passenger station at St. Louis; the State St., Wells St.,

Clark St., Adams St., Jackson St., Van Buren St., Wisconsin Central Ry. bridge at Polk St., in Chicago; all of which were first painted with red lead and subsequently with some other paint, usually oxid of iron. The wagon bridge at Omaha, the Madison St. bridge and Madison St. viaduct in Chicago, painted with an unknown paint, but having the appearance of being a white lead tinted. The Rush St. bridge and viaduct, Lake St. Elevated Ry. bridge, Jones & Laughlin's bolt shed, Adams St. viaduct, Jackson St. viaduct, Metropolitan Elevated Ry. bridge, Harrison St. bridge and viaduct, Polk St. draw and viaduct and Taylor St. bridge and viaduct, at Chicago, all of which were first painted with what appeared to be an iron oxid paint. Visits were also made to the shops of the Missouri Valley Bridge & Iron Works, and Lassing Bridge & Iron Works."

The results of the examination are embodied in a paper read before the American Society of Civil Engineers (May 1), an abstract of which is printed in *Engineering News* (April 18). The conditions discovered are such as to allay apprehension that this method of preservation may not be regarded in most cases as reliable. All the structures named were found to have rusted more or less under the paint. "In some cases this was very little, in others much worse, and it was found on all parts of the bridge, whether specially exposed to weather or not. The rust was in spots in most cases, the limits of the spots being often quickly reached. In most bridges the clean metal predominated. It was found, in general, that a metal which had come from the rolls with a smooth surface was much less likely to have rust under the paint than one which had left the rolls with a rough surface. Plates were, as a rule, freer from this rust than shapes or angles, though, when the latter were smooth, they were clean. Eye-bars were usually free from rust, and those portions of members in iron structures which had been heated in process of manufacture showed also less rust than others. The age of the structure did not seem to have special influence on the rust under the paint, as some of the bridges which had stood longest were much cleaner than others which had been built only a few years."

Of the bridges named, the Omaha and Blair bridge, though rusted externally, was found in good condition under the paint. It was painted in 1884, and has not since been repainted. Under white lead marks put on in the mill the metal was in all cases found clean. The rust under the paint was generally thin and inactive. Bridges that had been given a coat of oil in the shop were found cleaner under the paint than those which had not received such treatment. Paint composed of pure iron oxid and pure linseed oil was found tough and strongly adherent.

"The paint on the bridges painted with red lead, with the exception of that on the drawbridge at Omaha, was universally brittle and very easily removed. The same was true of the mill and shop marks, wherever found. On the Winona bridge, which had been painted with white lead as a finishing coat, the paint was cracking wherever exposed to sun. A few structures painted with carbon paint showed this to be non-cohesive and easily removed. The paint on the bridges in Chicago, which were painted with iron oxids, other than the one referred to above, was brittle in some cases, and in others tough; it appeared much better, however, than the red-lead paint."

Bridges painted with red-lead required repainting in 7 years at the outside, while most of them required repainting in 2 or 3 years. The oxid of iron is not the cause of the rust spots under the paint; these are precisely like those which appear on iron housed in shops. To secure best results from painting, thorough cleaning from existing rust spots is requisite. Scraping or the sand-blast should be employed for this purpose. Mr. Gerber thinks it to be impracticable to secure thorough cleaning of the plates, etc., by hand, and adds that "under present conditions it is desirable to oil metal in bridge shops rather than to paint it, inasmuch as oil is not an opaque covering, and the condition of the metal shows for itself, and

can be improved, after erection and before painting, if necessary."

The Abuse of Cement.

THE following is an abstract of a paper read by B. Butler before the Society of Engineers (April 1). and printed in *The British Architect* (April 5). There is no doubt that failures occurring with cements of good repute frequently result from the causes herein set forth.

"In very hot weather it is no uncommon thing for a cement to have a very quick initial set, and in using such a cement, therefore, in order to obtain its full strength, it must be mixed and in its allotted position within a very few minutes of adding the water. This often entails the mixing of very small quantities at a time, and, if due precautions are not taken a larger quantity is mixed than can be manipulated before setting commences. This generally results in the use of additional water, and the serious detriment, if not total destruction, of the setting properties of the cement. Many cases of failure have occurred which (the cement being of good quality, though somewhat quick in setting) point strongly to over-manipulation or 'killing.'

"The admixture of a very small proportion of dirt or loam is quite sufficient to materially deteriorate the strength of a concrete, and too much stress cannot be laid upon the necessity for seeing that all aggregates are free from any foreign dirty matter. A case of structural failure came under notice a short time back, in which the cement used was perfectly good, but the finer portions of the aggregate consisted of very fine sand, so fine that 60 per cent. passed through a sieve having 70 coles per lineal inch, and 80 per cent through a sieve having 50 holes per lineal inch. The structure of which it formed part had to bear a considerable thrust and, to aggravate matters, instead of this sand being properly mixed, large patches occurred in which there was no cement at all. In addition to this, the sand contained a considerable portion of loam or foreign matter, and it is not to be wondered at that failure resulted."

The neglect to properly cool, or aërate, cement is a frequent cause of trouble. To use cement hot from the mill is to court failure, though under some circumstances it may not fail. It is recommended, where cement is used in considerable quantities, that cooling sheds be constructed, with good dry boarded floors upon which the cement may be spread and aërated before use.

Exposure of cement either to hot sunshine or to frost may greatly injure the results. The first evaporates water needed to complete the crystallization, and frost acts by expansion to injure the surrounding concrete. During severe weather cement, if used, should be protected from frost. Careful attention to the following points is necessary to secure good results. (1) The cement should be sound, well ground, and of steadily increasing strength. (2) The setting properties of the material must be carefully ascertained. (3) The cement must be properly matured before use. (4) While setting, it must be protected from extremes of temperature. (5) The aggregate must be clean and well-proportioned.

American Originality in Engineering.

IN speaking editorially of the construction of the drainage canal now under construction at Chicago, *Engineering News* congratulates American Engineers, that notwithstanding they had before them the Manchester, Baltic, Suez, and other great European works of this kind they did not follow these precedents, but adopted original methods of their own. "With practically no experience in canal excavation on so large a scale, both engineers and contractors have evolved methods and apparatus for carrying on such work which will challenge the competition of the whole world for efficiency and economy. The importance of this fact is more far-reaching than the present work. It is only a matter of time when the proposed canal across the Isthmus of Nicaragua will be begun, let us hope by American capital and under American control, and then it will be to American engineers and contractors that we must look for successfully ac-

complishing the work. The surety that they can be depended upon to do it expeditiously and economically, which the experience of the Chicago drainage canal has afforded, cannot but help to aid in securing the faith of capitalists and the federal government in the feasibility of the great interoceanic canal." All this is well deserved praise for the engineering skill, and ready resource that have been displayed in the progress of this work, and which command world-wide admiration.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Civil Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Bridges.

†30855. The City Avenue Bridge over the Schuylkill River, Philadelphia. Ill. J. Vaughan Merrick (Jour Fr Inst-April.) 1400 w.

*30904. Girder Bearings. Editorial (*Eng*-April 5.) 2200 w.

31047. Preservation of Iron Structures Exposed to Weather. (Abstract.) E. Gerber (Eng News-April 18.) 2000 w.

31049. Proper Relation of Elastic Limit to Ultimate Strength in Structural Steel.—Letters from William R. Webster, A. C. Cunningham and Charles E. Stowell (Eng News-April 18.) 2400 w.

*31152. Notes on a Broken Pinion Shaft. Ill. Onward Bates (Jour Asso Eng Soc-March.) 900 w.

*31153. Country Road Bridges. C. C. Wentworth (Jour Asso Eng Soc-March.) 2200 w.

31203. The Erection of Bridges. Ill. Charles H. Wright (Eng News-April 25.) 1800 w.

31206. Notes on Soft Steel for Bridges. Harry J. Lewis (Eng News-April 25.) 4500 w.

31609. The Measurement of Live Load Strains in Bridges. Ill. J. Jay Hankensen and William H. Ledger (Eng News-May 9.) 5800 w.

Canals, Rivers and Harbors.

†30857. The Rise and Progress of River and Harbor Improvement in the United States. I. Y. Schermerhorn (Jour Fr Inst-April.) 6500 w.

30884. Growth of Traffic Through the St. Mary's Falls Canal (Eng News-April 11.) 1300 w.

*30940. The Improvement of the Lower Seine (*Trans*-April 5.) 3200 w.

30947. Repairs to Mohawk River Dam, Cohoes, N. Y. Ill. (Eng Rec-April 13.) 1000 w.

31045. Vertical Lift Lock for the Erie Canal at Lockport, N. Y., with Editorial. Ill. (Eng News-April 18.) 8200 w.

*31150. The Chicago Sanitary District Canal. Isham Randolph (Jour Asso Eng Soc-March.) 4000 w.

31224. The North Baltic Canal Locks, Holtenau. Ill. (Eng Rec-April 27.) 1300 w.

*31407. The Panama and Nicaragua Canals (*Bd of Tr Jour*-April.) 500 w.

31427. The Location of the Nicaragua Canal. Editorial. Ill. (Eng News-May 2.) 1100 w.

*31442. The Public Levee at Winona, Minn. Ill. Fred H. Pickles (Paving-May.) 1300 w.

31611. Cost of Dredging in the Lower Danube. Charles H. L. Kuehl (Eng News-May 9) 400 w.

Irrigation.

*30834. Irrigation Surveying in California.—Field Work in Locating the Canals. Ill. C. E. Fowler (Eng Mag-June.) 3000 w.

30981. Water Right Contests, From Spokesman's Review (Eng & Con-April 5.) 2000 w.

†31272. The Conquest of Arid America. Ill. William E. Smythe (Cent Mag-May.) 6500 w.

31410—$1.50. The Santa Ana Canal of the Bear Valley Irrigation Company. Ill. William Ham Hall (Am Soc Civ Eng-Feb.) 420000 w.

Miscellany.

30864. The Swelling and Shrinkage of Excavated Material. Charles Baillairge (Can Eng-April.) 2000 w.

*30937. The Abuse of Cement. (Extract) D. B. Butler (*Brit Arch*-April 5.) 1500 w.

*31154. Portland Cement Concrete at Fort Point. George H Mendell (Jour Asso Eng Soc-March.) 3500 w.

31425. The Effect of Freezing on Cement Mortars. Percy L. Barker and Henry Allen Symonds (Eng News-May 2.) 4000 w.

31430. A Heliotrope Flag for Engineers. Ill. Walter C. Parmley (Eng News-May 2.) 500 w.

†31488. Notes on Cement Laboratory Work. I. O. Baker (Tech-No 9.) 2000 w.

†31490. Hints Relating to the Practice of Railroad Surveying. A. C. Schwartz (Tech-No. 9.) 9000 w.

Serials.

27071. Graphic Methods of Taking Out Areas, Banks and Cuttings. Ill. R. E. (*Ind Engng*-Began Oct. 27—3 parts to date—45 cts. each).

28498. Thames Bridges. Ill. (*Engng*-Began Jan. 4—9 parts to date—30 cts. each).

30177. Irrigation in Peru. Ill. (*Engng*-Began March 8—Ended March 12—3 parts—30 cts. each).

30946. The Rivers of Central Asia. Ill. E. A. Sibold (*Ind Engng*-Began March 16—1 part to date—45 cts).

31039. The Baltic Canal and the Baltic Traffic (*Fairplay*-Began April 12—3 parts to date—30 cts. each).

31117. Traction of Boats on Inland Waterways. W. H. Wheeler (*Eng*-Began April 12—1 part to date—30 cts).

DOMESTIC ENGINEERING

The Best Position for Radiators.

W. H. PENNELL in *The Metal Worker* (April 20) holds that the proper position for radiators is not near the glass, as has hitherto been generally believed, but at some point remote from or opposite to windows. If the position of radiators had been studied only by a consideration of theoretical principles (in which case the overlooking of a single point might be fatal to accuracy of conclusions), Mr. Pennell's argument might stand a better chance with heating engineers. Unfortunately for his theory, the subject has been studied experimentally, and the results of experiment do not accord with his views. Thus he argues:

"A stove throws out or radiates heat laterally as well as upward, so that the room seems to be heated from the heat-rays thus sent off, for these rays are so strong that they quite conflict with the idea that the air becomes heated, and that the room is heated by the circulation of the air. When the air absorbs heat,—becomes heated,—it expands and rises very rapidly. The cause of the upward rush of the air being the heat absorbed, it is evident that the air will continue to rise as long as the amount of heat is constant. The heat from a column of heated air is absorbed or extracted slowly by the surrounding cold air, but, when a solid body is encountered, the heat is very rapidly discharged. As the air loses its heat, it is condensed, and, becoming heavier, it will fall towards the floor. The pouring of water from a vessel upon an iron plate from a considerable height will illustrate inversely the action of the air pouring out of a furnace-register up through the air of a room until it strikes the ceiling. As the water would flow away toward the lower portion of the plate, so the air flows away toward the colder wall more rapidly than in the other direction. As it flows along the ceiling, followed constantly by the renewed current, parting with its heat all the time, it seems drawn toward the colder portion more rapidly, so that, if there is an exposed wall or a window, the currents will be found to be most rapid in that direction. A simple experiment will determine this. Place a bit of aromatic gum or any smelling tincture upon the register of a hot-air furnace, and notice how much more quickly you will get the odor at a window than in any part of the room. When the heating apparatus is in the room to be warmed, whether it be a stove, a steam radiator, or hot-water radiator, the air is warmed by contact with the heater. Radiant heat is noticed most strongly from the stove, and least from the hot-water radiator. In fact, in moderate weather, when the water in the boiler is not over 100°, no radiant heat is recognized, horizontally, from a hot-water radiator. The currents of air coming in contact with the heated iron seem to carry all the heat in vertical lines. Because this is so, we will take the hot-water radiator to determine the proper place in the room for the radiator to best heat the room. It is evident that the air of the room must be warmed, and with it the walls of the room, the furniture, and all the solid matter of whatever nature, in the room, all to an equable temperature. What this temperature will be must be determined by the size of the radiator and temperature of the water. . . The moment the water is heated, the air in contact will rise at once from every part of the heating surface, being supplied from below by the colder air flowing in to take the place of that sent up toward the ceiling. The upward stream being constant, the flow toward the radiator must be equally constant, and the current toward the radiator will be the colder air, that near the floor the coldest, so that the very coldest place in the room will be at the floor near the radiator. We have seen that the air rises constantly to the ceiling, flows along the ceiling, parting with a portion of its heat down the walls to supply

the current that is all the time flowing toward the radiator, parting with the heat by contact with the walls, falling the more rapidly the more it is cooled, and most rapidly down the colder walls. Glass is transparent to heat, and so down past the windows the current flows most rapidly, but, as the current is drawn most strongly toward the window, a larger portion of the heated air is drawn in that direction, and therefore a larger quantity of heat will be carried to the floor, where, parting with still another portion of heat, the air will flow toward the radiator, to be again heated and sent into circulation. This should make the floor near the window the warm place, if the radiator is placed where it should be, upon the opposite side from the window. A careful study of the subject will convince one that the proper place for a radiator in a room is not under a window 'to make it comfortable to sit in'; and yet we find some who will place radiators where they would not put a stove. I have seen radiators set into a recess, with a screen in front under a window, cutting off all circulation of air."

Now, this all sounds very well, but there remains the fact that, no matter whether effects ought to be as Mr. Pennell describes, or not, a little experiment with good thermometers shows that they are not so. Although the colder air flows toward hot bodies placed on the floor of a room, and the warm air at the top flows toward the colder windows, just as Mr. Pennell says, it does not follow that the colder part of the room is at the floor near the radiator. This would perhaps be the case, did the air part with heat after reaching the mean temperature of the room, and so come back to the radiator considerably colder than, as a matter of fact, it does come, after a room has once been warmed to a comfortable temperature. But, in the use of good direct steam or hot-water radiators, there is considerable heat given off to the floor near the radiators, and the air flowing over that is in most cases warmed to a temperature above that of the mean temperature of the room before getting into actual contact with the radiator. Neither is glass transparent to dark heat, such as emanates from radiators, as Mr. Pennell asserts.

Flueless Gas-Stoves.

IT has been alleged frequently that the use of gas-stoves without flues to carry away the products of combustion is injurious to the occupants of rooms containing such stoves. This allegation is taken up in *Journal of Gas Lighting* (April 2), in an elaborate editorial review of an investigation made by Mr. Thomas Fletcher printed in the *British Architect*. This investigation related to the effect of Fuller's gas-stoves used in the chancel of a chapel in London. The first-named journal says of these stoves that "the statements made against them were so plausible and neatly put that they required consideration before their utter fallacy and incorrectness could be seen; and the facts were of very considerable importance, as they proved beyond question, not only the conditions caused by flueless stoves, but also the comparative impurities from different sources and the danger of attending crowded meetings." The alleged objections to the flueless stoves were "that they generate thousands of cubic feet of carbonic acid, which is dangerous and unhealthy; that the gas, when burning, pollutes the air with its organic impurities; that the sensation of welcome warmth prevents the badness of the atmosphere from being at once recognized, although the carbonic acid gas will produce its effect on the congregation," and "that the method of heating renders the air quite unfit for breathing."

"The building in question has a total floor surface of 47 ft. by 41 ft. The average height being 24 ft., the cubic space is 46,248 ft. The average congregation numbers 600. The floor surface is consequently $3\frac{1}{2}$ sq. ft. for each person, as against the 8-ft. minimum for board schools for infants. The cubic space for each person is 81 ft., as against 240 ft. minimum for a registered common lodging-house. These data are taken from Dr. Whitelegge's textbook on 'Hygiene and Public Health.' The building is lighted by 96 gas-burners. The consumption is not given; but, taking

it at the low average of 3 cu. ft., the total consumption will be 288 cu. ft. per hour for lighting only. The eight 'chancel' stoves for warming burn a maximum of 15 cu. ft. per hour each,—a total of 120 cu. ft. But it must be noted that these are never used while the congregation are assembled; they are lighted for some hours in advance only."

Computing the exact amount of carbonic acid gas produced by the four gas-stoves, it is found to be 61 cu. ft. per hour, instead of the "thousands" alleged, while the 600 persons assembled would exhale in the same time 480 cu. ft. of this gas and the gas-light 147. The total carbonic acid from the three sources would be 688 cu. ft. The stoves, therefore, were responsible for less than nine per cent. of the entire product. With reference to the accumulation of this gas in the chapel audience hall, in the absence of any ventilation whatever, and during the time in which the room was occupied, Mr. Fletcher found it to be 1.43 per cent., of which less than $\frac{1}{10}$ was due to the gas-stoves. Carbonic acid present to this extent in an apartment, when derived from simple combustion of fuel, is not injurious. That exhaled from the lungs of 600 people collected in a room of the cubic capacity named would, on the other hand, be contaminated with organic impurities which would, even in an hour, become offensive and injurious. A real defect of the flueless gas-stove is not that it contaminates the air by the products of its combustion (of course on the supposition that the gas is fit to be used as fuel in such stoves), but that it does not assist ventilation, as is the case with stoves that deliver the products of combustion into chimney-flues. The latter draw air from the apartment and pass it into the chimney. To replace that which thus flows out fresh outside air flows in, and thus a change of air is all the while going on.

Another defect that may result from the use of defective burners is the production of carbonic oxid, which, unlike carbonic acid, is an active poison, even when largely diluted, and which, when present in quantity too small to destroy life, produces a variety of unpleasant and injurious effects upon the animal economy. This defect may exist in oil-stoves as well as gas-stoves. Another objection to flueless gas- and oil-stoves is that a product of the combustion is water. The air in a room heated by either of these appliances is moistened artificially beyond the normal degree for a room heated by a stove with a flue. This, however, is objectionable only in apartments where dryness of the air is essential to the preservation of its contents in good condition. Thus polished steel articles will rust more readily in a shop heated with flueless gas-stoves than in one heated by steam, hot water, or a stove connected with a flue.

House Sanitation.

THE argument sometimes used against modern sanitary teaching—to wit, that a former generation lived long, useful, and honored lives without modern sanitary rules and appliances—is well answered by Dr. Moreau Morris in *The Sanitarian* for May.

"Some carpist, ignorant of the laws of healthy life, asks: 'Why was it that our ancestors were, many of them, long-lived and more healthy than the present generation, who knew nothing of the new-fangled terms of hygiene, sanitation, microbes, germs, disinfection, fumigation, etc., now so patent to everybody? They lived healthy, happy, prolonged lives.'

"With Yankee instinct we will answer by asking him a question.

"Did any of that ancestry live under any similar conditions? Do we find that they lived in those days in houses heated by furnaces or honeycombed by steam-pipes, with scarcely any ventilation, breathing the vitiated air of warm, close bedrooms, the noxious, sulphurous emanations of gas illumination, the poisonous sewer-gases eliminated by animal and vegetable decomposition, all of which fill not only our houses, but even our out-door air impregnated with the offensive effluvia of filthy streets, rows of overflowing garbage receptacles polluting the atmosphere? Did they spend their time in rounds of excitement, in various excesses of parties, balls, theatres, operas, and teas, turning

night into day, laying their weary heads upon sleepless pillows, indulging in unwholesome luxuries at unreasonable hours, suffering the untold horrors of chronic indigestion, to become unnerved and physically exhausted by hasty meals, competitive mental activities, railway rushing from town to town, stock-bulling or -bearing, working in factories, sweat-shops, or the thousand and one things that go to limit and destroy almost every chance for longevity? How long, do you think, they could live in this cyclonic kind of life that the present generation manage to endure?

"True, our present methods of living are wrong, and hence the sanitarian, the hygienist, must necessarily come to the front and sound the note of warning, point out the methods, the remedies, and the preventives that may limit the dangers of our environment. No; they lived in pure air, broad sunlight, with rain-baths to wash down into mother earth floating microbes; slept in cool, well-ventilated bedrooms at seasonable hours; ate plain, simple food; worked physically and mentally with even tenor; were not compelled to resort to drugs to obtain sleep nor combat indigestion. Happy in all the relations of life, with healthful occupations, free from the disturbing cares and anxieties of a crowded city life, it would indeed be a wonder why they should not have lived to a good old age.

"But we citizens of a city life are trying to live under very different conditions. Housed in unsanitary buildings; crowded into tenements, flats, and apartments; deprived of heaven's pure air and sunlight; compelled to breathe contaminated atmosphere indoors and outdoors; surrounded by bacteria of both kinds,—harmless and unwholesome,—we must rely largely upon expert sanitarians, whose practical knowledge can teach us how to live, to enjoy health, to prevent disease, and maintain hygienic environments."

Sunlight and free pure air are natural germicides, and are infinitely superior to any artificial substitutes. In the supply of these the modern city tenement-house fails most lamentably. The persistence of life in disease-producing micro-organisms is both amazing and appalling to those who approach the subject for the first time. No one yet knows what length of time will serve to destroy them, and dust, dirt, darkness, and dampness are their most loved haunts. Therefore too much stress cannot be laid upon perfect cleanliness in cellars, which, if not kept dry and free from household waste, may become veritable poison-beds for ourselves and our children. Clothing and textile fabrics should be frequently beaten and exposed to the air and sunlight. Carpets, when being swept, should be sprinkled with moist tea-grounds to prevent dust from rising. Feather-dusters and whisk-brooms are pronounced to be "domestic abominations." In their stead damp cloths should be used for removing dust. Roof-gardens are recommended. All wastes of whatever kind should speedily be removed, and the best way of doing this is by burning them up if this be practicable. All textiles, except such as are needed for the comfort of the patient, should be removed from the sick-room, as precaution against possible spread of infection, whenever a suspicion exists that a disease may possibly turn out to be of this nature. Further and minute directions for sanitation in case of the invasion of infectious diseases are given. A mass of sanitary information is compressed into the limits of this paper, which ought to be widely disseminated.

Holophane Globes.

THESE globes are a new invention for use with lights of high candle power, such as is afforded by the Welsbach system of lighting, and may also come in with acetylene lighting now in its very beginnings. The London Journal gives an account of this invention, which is due to Messrs. Blondel and Psaroudaki, and in doing so says that it appears to remove the chief obstacle to the complete popularity of all commercial high power lamps and light sources of high intensity and small surface.

"There are no illustrations available as yet whereby we might show the holophane globe in operation; but we can testify to the fact that it has the appearance, when inclosing an incandescent gas or electric-

lamp, of a vase filled with light, brilliant yet soft. The actual burner or filament cannot be discerned. The desideratum of the advocates of diffusion in lighting is thus in effect supplied, although the source of light is a mere line or spot. We are assured that it is the same with the electric arc light. As for the loss entailed by all this reflection and refraction, it is certified by M. de Nesville to amount in the case of an arc light to from 9 to 13 per cent. As this observer remarks, there is no other kind of globe in existence capable of realizing such a diffusion of light, and at the same time presenting such a uniformity of effect. Seeing that the loss of light by transmission through clear glass is 8 to 10 per cent., the claim for the holophane globes that they do their special work for about 4 per cent. of loss is well established.

"The principle of the holophane moulding is soon explained. The interior surface of the globe is formed into vertical grooves, which are so shaped as to spread out horizontally the rays proceeding from every part of the light source. They are thus moulded to one regular section. The mouldings on the outer surface of the globe are horizontal, and have the effect of distributing the emergent rays in the vertical sense; and inasmuch as the light may be required in some instances to be cast downward, and in others to be equally dispersed, the angles of the outside grooves are modified accordingly. This is a very different thing from the unscientific cutting seen in ornamental cut glass globes, which does nothing for the diffusion of the light." The analogy of this arrangement of facets to that of the Fresnel lens is apparent.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Domestic Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Heating and Ventilation.

*30837. Heating and Ventilating Tall Buildings.—Problems for the Architect, Builder, and Owner. Ill. Leicester Allen (Eng Mag-June.) 3000 w.

30849. Testing Fire Brick. Charles Ferry (Ir Age-April 11.) 2200 w.

30951. Hot-Water Heating of a Mission House. Ill. (Eng Rec-April 13. 900 w.

*31002. Steam and Hot-Water Fitting. F. G. Perkins (Dom Eng-April.) 3600 w.

*31003. Combination Heating. John Millar (Dom Eng-April) 3500 w.

*31004. General Directions for Furnace Work. George D. Hoffman (Dom Eng-April.) 1500 w.

31058. Heating and Ventilation of the South Evanston School. Ill. (Heat & Ven-April 15.) 1000 w.

31059. Fan-Blowers. Ill. Souffleur (Heat & Ven-April 15.) 600 w.

31060. Comparison of Steam Heating Boilers. Stephen Quentin Hayes (Heat & Ven-April 15.) 2200 w.

31086. The Proper Location of Radiators. W. H. Pennell (Met Worker-April 20.) 1000 w.

31115. Steam and Hot Water Heating. F. G. Perktns (Mas St Fit-April.) 4000 w.

31116. Greenhouse Heating. Extract from Paper by A. H. Douglas (Mas St Fit-April.) 800 w.

31245. Hot Blast System of Heating—Garden City Fan Company, Chicago (Sta Eng-April.) 400 w.

31471. Hot-Water Heating and Ventilation of a Church. Ill. (Eng Rec-May 4.) 800 w.

†31491. Test of a Heating System. L. P. Breckenridge (Tech-No. 9) 2000 w.

31543. Hospital Ventilation Morrill Wyman (Am Arch-May 4) 3000 w.

Landscape Gardening.

30861. A Notable Park Project in New Jersey. Editorial (Gar & For-April 10.) 1200 w.

31038. Public Reservations in the State of New York (Gar & For-April 17.) 1000 w.

31456. Paths and Roads. From Gardening World (Land Arch-Jan.) 1400 w.

Plumbing and Gas Fitting.

31174. Soil-Pipe Joints. Ill. Grayson (San Plumb-April 15,) 2800 w.

Miscellany.

*31001. Sanitary Engineering. Abstract of Lecture by William Paul Gerhard (Dom Eng-April.) 900 w.

†31104. Sanitation. C. W. Belden (In Arch-April.) 2200 w.

†31478. House Sanitation. Moreau Morris (San-May.) 5000 w.

Serials.

26907. Hot Water Heating and Fitting. J. L. Saunders (Heat & Ven-Began Nov. 15, 1894—5 parts to date—15 cts. each).

29334. Technical Subjects that Plumbers Should Know. F. Dye (*Plumb & Dec*-Began Feb.—3 parts to date—30 cts. each).

ELECTRICITY

Cost of Niagara Power to Consumers.

THE *Electrical World* (March 9) states that a conference was held on February 21 between a representative of the Niagara Falls Power Company and a committee of municipal representatives of Buffalo, in reference to the proposed undertaking for the transmission of power from Niagara to Buffalo. On the part of the Niagara company it was stated that it would not be possible to economically deal with an amount less than 10,000 h. p., but that the company would undertake to effect the transmission and distribution of power to this amount, provided a proper franchise was granted. The company would refuse consent to the fixing of a maximum or other price for power within the city; the consumer would find adequate protection against excessive charges in the fact that, unless electric power costs less than steam power, it will not be used. It being proposed by some that the city should buy the power from the company and distribute it to the consumers, the Niagara company offered three propositions: (1) to sell 10,000 undeveloped h. p. on the lands of the company at $10 per h. p. per annum (24 hours), as is now done in the case of the Niagara Falls Paper Co.; (2) to sell the same amount of power from the turbine-shafts at $13 per h. p. per annum; or (3) to sell 10,000 electrical h. p. from the company's generators at $18 per h. p. per annum, in the form of a 2000-volt alternating current. The somewhat remarkable statement was made that "the company cannot name a price for electrical power transmitted to the Buffalo city line, as in the question of transmission are involved the uncertainties of the losses and cost of operation and maintenance." Inasmuch as the company claims to own three separate rights of way over private land from Niagara to Buffalo, it is not easy to see precisely where the question of indefinite losses and uncertainty of cost of transmission and maintenance comes in. As a problem of electrical engineering, it certainly does not appear to present any very serious difficulties in the light of the abundant experience gained in such matters within the past 5 years.

Measurement of Artificial Illumination.

THE ELECTRICAL WORLD (March 9) prints a paper read before the recent meeting of the National Electric Light Association, by Professors E. J. Houston and A. E. Kennelly, in which the authors point out that the question whether or not a given area is sufficiently lighted cannot be so well determined from a knowledge of the number and grouping of the luminous sources and their candle-power as from a method of actually measuring the quantity of light received per unit of area by the particular surface whose degree of illumination it is required to know. For example, in street-lighting a certain minimum intensity of illumination is required, which may be more satisfactorily determined by an actual measurement of the minimum illumination than by computations depending upon a number of complex conditions, of which the photometrical intensity of the separate sources employed is only one. Such a method of measurement would remove a source of great annoyance both to electrical engineers and to municipalities by avoiding occasion for discussion of the actual candle-power of the arc-lights usually employed, since, if the contract provided that the illumination in any part of a lighted street should not be less than a certain minimum, it would only be required of the electrical engineer that he should install such lamps as will, with the spacing employed, give the minimum illumination contracted for. The authors describe a portable apparatus which they had devised for the purpose of making such measurements, the operation of which depends upon the fact that a certain intensity of illumination is required to render a definite object, such as a printed slip,

when viewed at a definite distance, clearly legible to the eye. A movable shutter operated by a milled-headed screw varies the quantity of light admitted through a small window to the test-object, and the corresponding intensity of illumination is read from a scale graduated in terms of the lux or candle-meter. It is stated that the apparatus requires no particular skill in use, and can readily be employed by an inexperienced observer. There can be no doubt that some instrument of this kind is an important desideratum in the outfit of an electrical engineer, and it would seem as if this apparatus, in spite of certain criticisms passed upon it by well-known experts, might serve its intended purpose very satisfactorily.

A Study of Electrolysis.

THE ELECTRICAL WORLD (March 23 and 30, and April 6 and 13), contains a series of papers by W. Stuart-Smith, in which the author gives the results of an elaborate investigation made by him last year in behalf of the San Francisco Gas Company, with the assistance of Mr. Frank P. Adams, electrician of the Stockton Electric Light Company, mainly for the purpose of determining what steps might need to be taken by companies owning buried pipes in order to prevent general corrosion by leakage-currents from electric railways. The pipes were uncovered and electrically tested in more than five hundred different places. Each test was continued for some little time, during the passage of from four to six cars, the changes due to the movements of the cars and their frequency being carefully noted,—a wise precaution, as by its means otherwise unsuspected peculiarities were discovered. The author justly criticises the utterly untrustworthy and misleading results which have been obtained by some experimenters by means of ammeter readings, of which he cites a number of typical examples, and gives reasons which appear conclusive for employing in his own work voltmeter readings only. The articles are accompanied by an excellent map showing the lines of electric railway in San Francisco, which serves to render intelligible the detailed *résumé* which is given of the result of a large number of measurements at different points mentioned in the text. It was discovered, among other things, that there is no real ground for the assumption frequently made that water-pipes are more liable to corrosion than gas-pipes, as the conductivity of a line of pipe of either kind is entirely determined by the joints, the body of the pipe itself having but little to do with the result. It was found that the numerous service crossings of the interlaced gas and water systems were extremely effective in distributing the current over a wide area; also, that for this reason the volume of current passing to and from the pipes at any one point was very small, and though, as stated, a large number of different places were excavated and examined, no signs of electrolytic action were found. The companies owning the pipes were accordingly advised that generally no danger need be feared on account of the potential relations observed, but that, should a point be found where a main or service pipe was corroded, the remedy would be to unite the gas and water systems by a conductor at that point. Mr. Stuart-Smith is of the opinion that, under the far more complicated conditions that exist in a network of conductors buried in moist earth, the broad assumption made by Mr. Farnham in his paper on telephone cable read before the Institute of Electrical Engineers, in which he took the ground that the conductors were in a dangerous condition when positive to the earth, is not altogether warranted. The results of the tests are so fully given by Mr. Stuart-Smith that any person who desires may follow and check them, and draw his own conclusions from the recorded phenomena. The gas and water companies of San Francisco are certainly entitled to great credit for undertaking to make so careful and thorough an investigation, and no less for permitting the details of the results to be thus freely published for general public information.

The Polyphase Motor.

THE London *Electrical Review* (April 5) has a paper by Rankin Kennedy on the induction motor, in which it is contended that the true method of studying the action

of these machines is to regard them simply as transformers, and that the phenomenon of the rotating poles has nothing to do with the matter. Mr. Kennedy says that "the power is produced by the induced current occurring at a time and place where it acts along with the magnetic flux next following upon that flux which set the said induced current up,"—a statement which, though not couched in unexceptionable English, seems to go straight to the root of the whole matter. He severely criticises, and apparently with justice, such examples of the mathematical treatment of the subject as that contained in Lieut. Reber's paper read before the American Institute of Electrical Engineers last fall, but shows that Mr. Steinmetz has employed a method of mathematical investigation in harmony with his own views as above expressed. Anything which Mr. Kennedy writes on the subject of inductive effects from alternating currents is always worth reading; he began experimental work on the subject at an early date, and has kept at it constantly, and—what is better—he is one of those too rare theorists who experiment first and write afterwards.

Electric Conduit Railways.

THE *Street Railway Gazette* (April 13) has an illustrated description of the underground conduit system of distribution for electric railway service which has just been installed on the Lenox avenue line of the Metropolitan Traction Company in New York city, under the direction of Mr. F. S. Pearson, formerly engineer of the West End system of Boston. From the description it would appear that the builders have depended far more upon excellence of material and construction, and careful attention to minute details, than upon any particular novelty of design. The track and conduit are essentially the same as that employed in standard cable railway construction, doubtless with the idea that, in case the electrical scheme proves unsatisfactory, the ordinary cable may be substituted without unnecessary delay or expense. The only feature of the plan which calls for special notice is the type of electrical conductor employed, which consists, not of wires, but of 4½-in. iron channel-bars 30 ft. in length, insulated and supported at their adjacent ends, but not elsewhere, upon substantial pillars of soapstone. Manholes are provided at each point of support, these being the only points where trouble is likely to occur. It is not unlikely that a more efficient insulator may ultimately prove to be necessary, but, on the whole, it looks as if this system embodied elements of success. The pressure to be used in the first instance is only 300 volts. If the permanent operation of this line is as successful as there is reason to think it will be, it may have the effect of introducing an entirely new condition of affairs in respect to trolley cars in large cities. The practical results of the operation of this line will be awaited with interest.

A New Thermo-Electric Generator.

EVER since the discovery by Seebeck in 1831 that the direct conversion of heat-energy into electric-energy could be effected by applying the heat to the point of junction of two dissimilar metals, occasional efforts have been made to construct a practical apparatus, some of which have started out with an apparently fair prospect of success. The fatal defect has always proved to be in the instability of the apparatus; after a little use, it invariably gave way at the point of junction of the two metals. In the *Electrical Engineer* (May 1) Mr. H. B. Cox describes an apparatus which he has designed and constructed, in which the unlike members of the thermo-electric couple are alloyed into each other, as it were, at their abutting ends, so that there is no definite point of junction. A generator of this type is stated to have been in constant use for three years, without giving any indications of deterioration. The article is accompanied by an illustration of a small generator weighing 3 lbs., which is fitted to a gas-burner consuming 1½ cu. ft. per hour, and is said to give an electrical output of 5 volts and 5.5 amperes, or .037 horse-power. A larger generator, using coal for fuel, generates current, at a cost of one-

fifth of a cent per lamp-hour, from coal at $4.50 per ton. If these results are capable of verification upon an extended scale, it is impossible to over-estimate the importance of Mr. Cox's discovery. It opens the way to nothing less than a complete revolution in our present methods of obtaining power from heat-energy. It is stated that the entire system of the Commercial Cable Company is to be operated by these generators as soon as possible, a test of several weeks having demonstrated their economy and efficiency to the entire satisfaction of the management.

High Pressure v. Low Pressure.

IN the London *Electrical Review* not long ago Mr. Rankin Kennedy has a thoughtful and well-considered paper, in which he seeks in some measure to forecast the direction of future development of electrical distribution. He points out that the system which is now rapidly coming to the front is the dual or compound system, high pressure being used at the central station to feed local sub-stations, from which a low-pressure system of mains serves to supply the neighboring consumers. This, it may be noted, is also distinctly the tendency of the most recent practice in this country. Mr. Kennedy doubts, however, whether such a system presents any real advantages over others, in many of the places where it has been installed. "There arises"—he says—"a very nice question for engineers, as to how much is to be gained in any given case by the use of high-pressure feeders, and under what circumstances are the advantages of high pressure great enough to warrant its adoption?" It must be borne in mind that electrical energy in the form of a continuous current is much more generally useful than in the form of an alternating current. This fact has perhaps not hitherto been fully realized, for the reason that both kinds of currents are equally good for the purpose to which electrical energy is at present most largely applied,—that is, of lighting incandescent lamps. When a supply is first laid down, the difference in cost between a high-and a low-pressure system is much greater than it will be later on as the full load comes up, because at first the low-pressure mains are few and short and not heavily loaded; hence engineers find that they can make a start with much less capital outlay on the high-pressure system, and therefore it is adopted without sufficient consideration of the future. In this way Mr. Kennedy thinks that low-pressure plants are often unfairly and unfavorably compared with high pressure plants. It is only later on, when the cost of the added low-pressure mains can be taken into account, that a true comparison can be made. With an improved system of storage, the generating plants at present in use might supply seven times the present annual output. The advent of this improvement, Mr. Kennedy thinks, "would knock the bottom out of the whole alternating current plan." The great future of the alternating current, in his opinion, lies in transmitting large quantities of energy over long distances, by phasal systems, as at Niagara. He entertains no doubt of the ultimate success of luminescent lighting,—the secret of the fire-fly,—and indeed goes so far as to express his conviction that we already have the key to the solution of the problem. What seems to be most needed is a general interpretation of the meaning of the results and data bearing on the subject, which have already been accumulated by industrious investigators.

The Cost of Electrical Supply.

THE actual cost of supplying electrical energy to consumers, especially in the form of light, is a matter about which there has already been a great deal of discussion, but in respect to which very much yet remains to be learned. Another problem closely related to this is that of the most equitable basis of charge to consumers, and it is one which presents a great many difficulties. In the London *Electrician* Arthur Wright has recently published a very instructive paper, in which he gives the results of the methods adopted by him at the station in Brighton, England, a town having some of the social and commercial characteristics of our own

Newport. Mr. Wright's general plan may be said to be that of charging a high rate per unit consumed, until each consumer's proper portion of the fixed charges has been reached (these latter amounting in the case of the Brighton station to 80 per cent. of total expenditure), and above that point, of making a material reduction. He points out that, were it not for the fact that only some 13 per cent. of the consumers use the light at all during 3 months in the year (an average of less than 1 hour per day), the present plant would be of ample capacity to supply the increasing business for at least 2 years, whereas, by reason of their existence, it is necessary to install additional plant to take care of the winter's load. The item of expenses includes really but two divisions, fixed charges and running cost, and hence, as Mr. Wright points out, it is necessary only to have two rates of charge for the consumer in order to obtain a perfectly equitable sliding scale of rebates, which, he assures us, involves but little more clerical work than a uniform price system. Mr. Wright insists strongly upon the superiority of a system giving rebates based on a consumer's actual use of the generating plant and conductors over one based on the more or less prolonged use of all the lamps installed. The former encourages the general use of electric light, while the latter has a contrary effect, and is, moreover, based on an unsound principle, as the preponderating fixed charges are not altered in any way by the proportion of the total number of lamps in a house which remain unlighted.

Electricity as a Profession.

In a pithy and forcibly-written article in the *Electrical World* (March 16) Frederick H. Ford expresses the opinion that the pressing demand at the present time is not so much for educated electrical engineers as for educated capitalists; men who are capable of understanding that it is better to employ those who know why things should be done and who will look after economy in the output than to hire cheap men and waste the salary of a good man in inefficient methods of working. "When capital has been so educated," says Mr. Ford, "and not until then, will the relation between work done and pay received by the [electrical] engineer compare favorably with that of the lawyer, the doctor, the writer, or the merchant." It is certainly true that at the present time the closing of many large electrical works on account of patent litigation or financial trouble has thrown out of employment a large number of electrical engineers of experience and ability, and the visible supply of this particular variety of talent is so much in excess of the demand that salaries have been forced down to a point absurdly out of proportion to the expenditure of time and money, to say nothing of hard work, which an electrical engineer must necessarily incur in fitting himself for the practice of his profession. This is a condition of affairs that should receive the serious attention of all young persons who are about to determine upon their vocation in life.

Danger from Alternating Currents.

In a communication in the *Electrical World* (March 23) Mr. W. D. Dickinson mentions several specific instances in which persons have received severe shocks, in one instance resulting fatally, from the secondary circuits of an alternating system, and states that in each case it was found upon subsequent investigation that a connection had been formed, usually by the action of lightning, between the primary and secondary circuits of a transformer. As the manager of an electric plant, these accidents have caused Mr. Dickinson much anxiety, and he anxiously inquires what means, if any, have been successfully employed by others for obviating the trouble.

Exasperating Electrification.

It is well known by experienced printers that the output of the press-room is greatly reduced, during cold, dry winter weather, by the annoyances and interruptions due to the undesired presence of static electricity in the paper which is being printed upon, as manifested in smutting, imperfect delivery, etc. A correspondent, writ-

ing in the *Electrical World* positively states that an effectual remedy has been found in a perforated steam pipe, which liberates a quantity of moist vapor immediately under the sheet of paper as it leaves the cylinder after being printed. Another correspondent says that, in another establishment, a current of warm air has proved an equally efficacious means of dispersing the troublesome static charge. If this is the case, printers generally will have good cause to thank the originator of the device, whoever he may be.

Electric Transmission at High Voltages.

A WRITER in the *Electrical World* recently made the statement that there is at present no electrical plant in operation at a pressure higher than 10,000 volts. In reply to this, Mr. Emil Kolben of the Oerlikon Works, near Zurich, Switzerland, writes to the same journal that the power-plant by which those works are driven has been in successful and continuous operation for more than three years at an effective pressure of 13,000 volts. He further says that no serious trouble has been experienced with the insulation of the line, which is bare copper supported on large porcelain insulators of a special type. This is a very important piece of practical information.

THE *Electrical World* (March 23) publishes specifications drawn up by the National Academy of Sciences, in accordance with the act of congress of July 12, 1894, establishing and defining certain units of electrical measurement, for the practical reproduction of ampere and volt. The directions are minute and specific.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Electricity in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Lighting.

30843. A Modern Electric Light Station.—First District Station of the Edison Electric Illuminating Company, of Brooklyn. Ill. (Elec Wld-April 13.) 900 w.

30852. Electric Lighting of the New York and Brooklyn Bridge Cars. Ill. (Elec Eng-April 10.) 2400 w.

30854. The Arc Light for Municipal Street Purposes. Ill. I. C. Wood (Elec Eng-April 10.) 2300 w.

30866. The Manufacture of Incandescent Electric Lamps. Ill. (Sci Amer-April 13.) 800 w.

30878. Specifications for Street Lighting by Arc Lamps. William Pierson Judson (Eng News-April 11.) 1400 w.

30889. Reception of the Edison Electric Illuminating Company, of Brooklyn. Ill. (Elec Age-April 13.) 1000 w.

*30974. The Coupling of Dynamos for Arc Lighting. W. H. Lea (*Elec Eng*-April 5.) 1200 w.

30999. The New Station of the Citizens' Electric Illuminating Company, Brooklyn, N. Y. Ill. (Elec Rev-April 17.) 800 w.

31035. Electrical Enterprise in California.—The Los Angeles Electric Company. Ill. George Heli Guy (Elec Eng-April 17.) 1800 w.

31062. An Office Building Lighting Plant. Ill. (Elec Wld-April 20.) 1000 w.

*31080. Electric Lighting for Large Buildings. George White Fraser (Can Arch-April.) 1200 w.

31083. The Improved Ball System of Electric Arc Lighting Ill. F. B. Widmayer (Elec Age-April 20.) 1800 w.

*31113. Sodium in Electric Light Boxes — Report of Committee of Investigation (*Gas Wrld*-April 13.) 1200 w.

31186. Underwriters' Rules. William A. Anthony (Elec-April 24.) 1300 w.

31187. Practical Wiring Specifications. A. E. Dobbs (Elec Eng-April 24.) 900 w.

31201. The Heat of the Electric Light. C. C. Haskins (W Elec-April 27.) 800 w.

*31283. The Photographic Testing of Projector Reflectors. Ill. V. Tchikoleff (*Elec Eng*-April 19.) 700 w.

*31514. The Electric Lighting of the Houses of Parliament. Ill. (*Eng*-April 26.) 2700 w.

*31531. New Methods in Central Stations—Belfast and Leicester. Ill. (*Elec Rev*-April 26.) 6 00 w.

31574. Polyphase Currents for Lighting and Power in a Factory. M. P. Boucherat (Elec Rev-May 8.) 1000 w.

31575. An English Municipal Lighting Plant—Manchester, Eng. (Elec Rev-May 8.) 1500 w.

31604. Louisville Auditorium Plant. Ill. (W Elec-May 11.) 1500 w.

Power.

30883. Water-Power Development with Electric Transmission, Folsom, Cal. Ill. (Eng News-April 11.) 800 w.

*30932. The Early History of the Polyphase Motor. Rankin Kennedy (*Elec Rev*-April 5.) 1200 w.

We supply copies of these articles. See introductory.

31040. Distribution of Power from Niagara. Ill. Frank C. Perkins (W Elec–April 20.) 3400 w.

*31102. The Cost of Electric Energy for Private Installations. Editorial (*Engng*–April 12.) 2000 w.

*31106. Transmission of Power by Electricity. W. C. Mountain (*Col Guard*–April 11.) 5400 w.

31169. Electric Apparatus in Use for the Construction of the Jetties of the Port of Bilbao. Ill. P. H. Van der Weyde (Mnfr & Builder–Dec.) 500 w.

31217. Power Cheaply Produced (Safety V–April 15.) 700 w.

*31258. Recent Papers on Dynamo Design. Editorial (*Electr'n*–April 19.) 1500 w.

31401. The Cox Thermo-Electric Generator for the Conversion of Heat Directly into Electrical Energy. Ill. Harry B Cox (Elec Eng–May 1.) 2800 w.

31402. The De Bovet System of Electric Canal Boat Traction. Ill. (Elec Eng–May 1.) 400 w.

31449. Power Consumed on Electric Railways. G. Pellissier (Elec Age–May 4.) 1400 w.

†31570. Dynamo and Motor Design. Gano S. Dunn (Jour Fr Inst–May) 1500 w.

31576. An Electrical Ferry Service. Ill. (Elec Wrld–May 11.) 700 w.

31585. The New Power House of the Columbus Central Railway Company. Ill. (Elec Ind–May.) 1600 w.

Telephony and Telegraphy.

30844. The Perrin, Bonta and Cole Telephone Patents. Ill. (Elec Wld–April 13.) 1800 w.

31000. Telephones in England (Elec Rev–April 17.) 1000 w.

31037. Long-Distance Microphone Transmitter . Editorial (Elec Eng–April 17.) 1000 w.

31168. Telegraphing Without Wires. Ill. (Mnfr & Builder–Dec.) 800 w.

31176. Automatic Telephone Exchange.—Constructed by Deckert and Homolka. Ill. Victor M. Berthold (Elec Rev–April 24.) 900 w.

31376. American Bell's Weakness. Facts and Figures Concerning the Present Status of the Telephone Business (Elec–May 1.) 4000 w.

31446. Reorganization of the Mutual Automatic Telephone Company. From Philadelphia Ledger (W Elec–May 4.) 1000 w.

31476. Long Distance Signalling. A Scheme for Sending Heliograph Messages from Washington State to Mexico (Bos Jour Com–May 4.) 500 w.

Miscellany.

*30838. Power, Light and Heat in City Blocks.—The Combination of Electricity and Steam. Ill. J. E. Talbot (Eng Mag–June.) 3000 w.

30845. Armature Reactions in a Simple Alternator Compared with that in a Multiphase Generator. Ill. Ossian Chrytraeus (Elec Wld–April 13.) 500 w.

30860. A Pioneer in Electricity—Sir Francis Ronalds. John Syme (Elec–April 10.) 2800 w.

30886. Variation of Internal Resistance of a Voltaic Cell with Current. Henry S. Carhart (W Elec–April 13.) 800 w.

30887. Proposed Board of Electrical Examiners for Chicago (W Elec–April 13.) 1800 w.

*30933. On the Diselectrification of Air. Ill. Lord Kelvin, Magnus MacLean and Alexander Galt (*Elec Rev*–April 5.) 800 w.

†31010. Resonance in Alternating Current Lines. Edwin J. Houston and A. E. Kennelly (Tr Am Inst Elec Eng–April.) 6500 w.

31063. Patents for Electrical Inventions (Elec Wld–April 20.) 2400 w.

*31122. On the Question of Dielectric Hysteresis. Ill. Alfred W. Porter and David K. Morris (*Elect'n*–April 12) 1200 w.

*31127. Dr. Keith on the "Electrolysis" and "Analysis" of Elementary Bodies, with Illustrations of Criticism. Desmond G. Fitzgerald (*Elec Rev*–April 12.) 1600 w.

31164. Contribution to a Theory of Synchronous Induction Motors. Alexander Rothert (Elec Wrld–April 27.) 1800 w.

31165. The Galvanometer in Practice. Ill. Louis Denton Bliss (Elec Wrld–April 27.) 1200 w.

31175. Dynamic Apoplexy.—True Cause of Death by Electrification. Ill. J. Mount Bleyer (Elec Rev–April 24.) 1400 w.

31185. The Varying Cost of Electricity. Arthur Wright (Elec–April 24.) 1200 w.

31192. The United States Units of Electrical Measure (Sci Amer Sup–April 27.) 1500 w.

31212. The Legal Aspects of Electrolysis. (Abstract.) Henry C. Townsend, in Cassier's Mag. (Elec Age–April 27.) 1500 w.

*31256. Note on the Force Experienced by Iron-Embedded Armature Conductors. W. B. Sayers (*Elect'n*–April 19.) 900 w.

*31257. The Electrical Industry in London. Guido Semenza (*Elect'n*–April 19.) 2700 w.

*31259. On Supposed Magnetic Fatigue. Albert Campbell and R. P. Lovell (*Elect'n*–April 19.) 450 w.

*31278. The Force Acting at the Surface of Separation of Two Dielectrics (*Elec Rev*–April 19.) 450 w.

*31281. Material for Wire for Rheostats for Strong Currents. K. Strecker (*Elec Rev*–April 19.) 600 w.

*31282. On the Law of the Dissipation of Energy in Dielectrics under the Action of Electric Fields of Feeble Intensity. (Abstract.) Riccardo Arno (*Elec Rev*–April 19.) 700 w.

31368. The General Electric Company's Porcelain Factory at Schenectady, N. Y. Ill. (Elec Rev–May 1.) 1500 w.

31369. The Scientific Foundations of Electrical Engineering. F. G. Baily (Elec Rev–May 1.) 2000 w.

31370. Experiments with Electric Waves. Alfred G. Dell (Elec Wrld-May 4.) 700 w.

31371. On the True Dimensions of the Electrostatic and Electromagnetic Units, and on the Right Use of the Terms Intensity, Strength, Force and K. Reginald A. Fessenden (Elec Wrld-May 4.) 2000 w.

31375. General Electric's Third Annual Report (Elec-May 1.) 900 w.

31447. Electricity at the Atlantic Exposition. H. M. Atkinson (W Elec-May 4) 1400 w.

31448. Action of the Electric Current on Fused Sulphurets. Jules Garnier (W Elec-May 4.) 600 w.

31450. Local Action in Accumulators. G. Darrieus (Elec Age-May 4.) 1500 w.

31477. How Lightning is Kindled (Bos Jour Com-May 4.) 500 w.

†31486. Some Experimental Data on the Design of Electro-Magnets. Ill. William Esty (Tech-No. 9) 7800 w.

*31515. The Use of Electricity for Cooking and Heating. Ill. R. E. Crompton, with Discussion (*Jour Soc of Arts*-April 26.) 7000 w.

*31536. A Magnetic Tester for Measuring Hysteresis in Sheet Iron. Professor Ewing (*Elec Eng*-April 26.) 4200 w.

*31558. Safety Precautions in Connection with Underground Mains in Berlin. From paper by Dr. Martin Kallman (*Elect'n*-April 26.) 1200 w.

†31568. Recent Advances in Electro Chemistry. Joseph W. Richards (Jour Fr Inst-May.) 9500 w.

†31569. Electricity Directly from Coal. Alfred H. Bucherer (Jour Fr Inst-May.) 1500 w.

31577. Galvanometer Construction at Lehigh University. Ill. Edwin E. Fisher (Elec Wrld-May 11.) 2000 w.

31583. Non-Magnetic Electric Devices. Ill. W. E. Irish (Elec Eng-May 8.) 2500 w.

Serials.

22131. The Incandescence Lamp. A. Bainville (*Elec Rev*-Began May 11, 1894—9 parts to date—30 cts. each).

23866. Electrodynamic Machinery. Edwin J. Houston and A. E. Kennelly (Elec Wld-Began July 21, 1894—35 parts to date—15 cts. each).

25895. The Design and Specification of Electric Lighting Works for Architects and Civil Engineers. Howard Pentland and Alfred H. Gibbings (*Elec*-Began Oct. 5, 1894—30 parts to date—30 cts. each).

25907. The Alternating Current; Its Generation and Distributlon. Ill. George D. Shepardson (Elec Ind-Began Oct., 1894—6 parts to date—15 cts. each).

26592. Electrical Power Transmission. Louis Bell (Elec Wld-Began Nov. 10, 1894—20 parts to date—15 cts. each).

27371. The Electric Light. Ill. Henry Stooke (*Ill Car & Build*-Began Nov. 23, 1894—23 parts to date—30 cts each).

29156. Technical Telegraphy Papers. Ill. James Bell and S. Wilson (*Elec*-Began Feb. 1—11 parts to date—30 cts. each).

29158. The Construction and Use of Electrical Measuring Instruments. Charles H. Yeaman (*Elec*-Began Feb. 1—12 parts to date—30 cts. each).

30305. Electrical Condition of Buried Conductors Due to Leakage Currents from Electric Railways. W. Stuart Smith (Elec Wld-Began March 23—4 parts to date—15 cts. each).

30674. Gas Batteries. Ill. C. J. Reed (Elec Wld-Began April 6—2 parts to date—15 cts. each).

30696. Electric Power Transmission. Ill. T. H. Leggett (From Trans. Am. Min. Eng.) (Min & Sci Pr-Began March 30—Ended April 6—2 parts—15 cts. each).

30799. The Future of the Steam Engine. Foree Bain (Elec Ind-Began April—2 parts to date—15 cts. each).

30853. Classification and Selection of Lighting Systems. Francis B. Crocker (Elec Eng-Began April 10—Ended April 17—2 parts—15 cts. each).

30859. The Tesla Two-Phase System. Nelson W. Perry (Elec-Began April 10—Ended April 17—2 parts—15 cts. each).

30872. Telephony. V. Wietlisbach (Elec Engng-Began April—1 part to date—15 cts).

30938. Lighting, and Electric Lighting as a Business. George White Fraser (Can Elec News-Began April—1 part to date—15 cts).

30939 Dynamo Design (Extracts.) E. B. Merrill (Can Elec News-Began April—1 part to date—15 cts).

30973. Electric Mains in Paris. Ill. A. Monmerque (*Elec Eng*-Began April 5—2 parts to date—30 cts. each).

30975. Effective Electric Lighting. Ill. W. Perrin Maycock (*Elec Eng*-Began April 5—Ended April 12—2 parts—30 cts. each).

31166. Curves for Winding Magnets. Harrison H. Wood (Elec Wrld-Began April 27—2 parts to date—15 cts. each).

31184. Opportunities in Electrical Engineering. A. A. Atkinson (Elec-Began April 24—2 parts to date—15 cts. each).

31188. Submarine Telegraph Cables. Ill. Samuel Trott (Elec Eng-Began April 24—Ended May 8—3 parts—15 cts. each).

31284. Electric Lighting of Trains. R. W. Weekes (*Elec Eng*-Began April 19—1 part to date—30 cts).

31344. Practical Telephony. Ill. James Bell (*Elec*-Began April 19—2 parts to date—30 cts. each).

31530. Alternating and Interrupted Electric Currents. Report of lectures by George Forbes (*Elec Rev*-Began April 26—1 part to date—30 cts).

31586. Factory Practice in the Design and Construction of Dynamos. Ill. C. E. Woods (Elec Ind-Began May—1 part to date—15 cts).

INDUSTRIAL SOCIOLOGY

The Influence of Workmen-Shareholders in Industrial Control.

It has been asserted that the scheme of admitting workmen to a share, not only in the pecuniary interest, but also in the control, of large industries would be, as a rule, fatal to the prosperity of such industries. Evidently such a proposition can only be effectively proved or refuted by facts such as advocates of either view have up to a recent date been unable to furnish. This state of things no longer exists. Experiments in admitting workmen to a share in control have been made, and the results have removed this contention from the realm of conjecture to that of evidence. Such evidence we find in *Journal of Gas Lighting* (April 23), in the form of testimony culled from the minutes of evidence taken by group C of the (English) labor commission, being the testimony of Mr. George Thompson, managing director and chairman of the firm of Messrs. Thompson and Sons, Limited, Woodhouse Mills, Huddersfield, England.

"Mr. Thompson has 30 years' experience of his trade; and his company employed 140 work-people. He told the commisioners that, in addition to the wages, the firm had a profit-sharing scheme, under which 80 per cent. of the work-people became copartners and shareholders in the concern. Mr. Thompson's statements as to the effect of the scheme upon the participants are a revelation for those capitalists who are unwilling to ascribe even common honesty to British workmen when uncontaminated by imported socialistic poison. In reply to Mr. Mawdsley (we quote from the official notes), the evidence ran as follows:

"'(Q. 7136.) Have these working-shareholders any one of their number on the directorate?'—'Yes; they could not be on the directorate unless they were holders.' (Q. 7137.) 'Are any of the directors taken from the ranks of the workmen?'—'Yes; three are taken from our own workmen, and three others (at present we have lost two by death) are representatives of the workmen outside.' (Q. 7138.) 'Have the directors any power in controlling the business of the company,—apart from yourself, I mean?'—'Not initiation exactly; but all great changes, important orders of machinery, and so on,—all are discussed by them.' (Q. 7139.) 'What do they do when they discuss them? Do you decide on your own responsibility afterwards, whether you will accept their suggestions or not?'—'No; I think there has never been a case of that kind.' In answer to further questions, witness said that, out of seven actual directors,—there being two death-vacancies waiting to be filled at the next annual meeting,—three were workmen in the establishment and three others were workmen outside. The board meetings are held monthly, and there are occasional meetings of what is called the mill committee, composed of the chairman and the three workers in the mill, who report to the full board. Question 7160, by Mr. Courtney, ran as follows: 'And you have never had any difficulty between yourself and your fellow-directors?' The answer was: 'Never; we have occasionally small differences of opinion, but we have never had any trouble whatever. I think one of the pleasantest experiences I have had is working with my committee in this matter. I have only omitted one meeting for the five years that we have been in existence.' Much of the witness's evidence was addressed to showing the difficulty of improving a trade that happens to be largely affected by changes of fashion."

One of the publications of the Labor Association is a pamphlet on the "Exhibition of Coöperative Productions at the Crystal Palace last August," from which the further facts stated below and bearing upon this subject are gathered.

The Alcester Coöperative Limited started in a very small way in 1889. This is described as a venture in an extremely

difficult trade, and under the rules the committee includes "two workers." The Bristol Pioneers' Boot and Shoe Productive Society has working members eligible for the committee. Brownfield's Guild Pottery Society, Limited, appears to be managed by the workers. The Burnley Self-Help Cotton-Spinning Manufacturing Society, Limited, is administered by a committee elected from the workers. Of the Coventry Coöperative Watch Manufacturing Society, Limited, it is stated that "the governing body is a committee consisting almost entirely of practical watchmakers, and they have directed the society well." Many other similar instances might be cited, among the most important being the Leicester Coöperative Boot and Shoe Manufacturing Society, Limited, secretary and committee all elected in general meeting by the workers themselves out of their own body. Those who desire further information upon this and cognate subjects are referred to Mr. Blanford's pamphlets and other publications of the Labor Association, including the monthly periodical entitled "Labor Copartnership," which is a record of the results of the working of over a hundred societies, doing a trade of £1,300,000 a year, whose workers share in profit, capital, and control.

The *Journal of Gas Lighting* thinks the application of this system to the gas industry would present fewer difficulties than have been encountered in the instances cited, and advocates a trial of it, among other things remarking that "a beginning must be made with gas undertakings somehow, if this industry is not to remain outside the operation of the reforming method of internal copartnership. It is not a method to be forced upon any undertaking, without the good will of both parties to the bargain of employment. But—and the point is a grave one—there is every reason why any advance of the kind should be made from above,—from the 'haves' for the benefit of the 'have-nots.' This is the way of English reforms; and it distinguishes them from revolutions. Not only political, but industrial, history is full of examples of concessions freely granted by those who had the power to give and to withhold,—not in response to clamorous demand, but in accordance with the promptings of an enlightened sense of the right."

Fallacies that Fool Fiatists.

THE reviews in this department are made with a view to indicate as far as possible the currents and counter-currents of thought upon social questions. Many an argument with which we can not agree appears in current discussions, but which is so presented that it cannot fail to arouse interest in important questions, upon which all well-meaning citizens will be forced to think for themselves before a settlement of the present unrestful condition of society can be reached.

One of the things that causes general uneasiness is the money question. Mr. I. W. Porter, in a letter to the editor of *Social Economist*, voices this uneasiness when he says that "our government is getting into deep trouble, while the industries and commerce of the country are well-nigh paralyzed, because the laws of the country are not obeyed." Of course the claim that silver dollars are full legal-tender money is here referred to. Upon this assertion Mr. Porter threads a string of questions, to which the editor makes reply, each of the "fallacies that fool fiatists" which he enunciates, and which are hereinafter stated, referring to some direct or implied interrogatory in Mr. Porter's letter. This correspondent begins his letter with the allegation that "the fatal defect of all the plans for relieving the country by currency laws, if we except Mr. St. John's and General Warner's, is that they ignore the law of legal tender, and appear framed entirely in the interest of the banks."

In replying to this letter, *Social Economist* first discusses what it calls "the legal-tender fallacy," and follows with no less than eight more "fallacies,"—to wit, (2) "the depression or low-prices fallacy"; (3) "the cheap-money fallacy"; (4) "the interest-gorgon fallacy"; (5) "the flexible-'yard-stick' fallacy"; (6) "the follow-France' fallacy"; (7) "the 'fiat-money' fal-

lacy": (8) "the 'greatness-of-government' fallacy"; and (9) "the decline-in-prices fallacy." We will try to indicate the line of argument whereby it is sought to prove that these notions are really fallacies.

(1) Of the legal-tender law it is said that there is a higher law. "'Thou shalt not steal' by paying a dollar of debt with 50 cents of value." And it is intimated that sticklers for the legal-tender laws are doing the banks injustice by failure "to recognize the fact that they" (the banks) "may honestly believe that, besides the legal-tender laws, there are laws of value or economic laws which are higher than legal-tender laws, and that one of these economic laws is that, if silver can be continuously produced at a cost of only eight to one, as compared with gold, and, when produced, can be freely coined at a nominal value of sixteen to one as compared with gold coin, then the value of silver coin, under free coinage, must fall to its cost of continuous production,—*i. e.*, the value of a silver dollar freely coined must fall to 50 cents in the United States, as it has fallen in Mexico. Believing this, and not desiring to see American standard dollars sink to half their value, are bankers not bound in honor as well as interest to oppose free coinage of silver, under a law of economics which is higher than the legal tender law,—viz., 'Thou shalt not steal' by paying a dollar of debt with 50 cents of value"?

(2) Of "the depression or low-prices fallacy" it is remarked "that in the decade between 1883 and 1893, according to reports of our director of the mint, the stock of standard silver coin in use in the commercial world has been increased by $1,300,000,000, or by fully half as much in 10 years as the whole silver coinage of the previous four centuries had accumulated. About $580,000,000 of this addition has been made in the United States, and is represented by United States certificates payable in silver. If plenty of standard silver could help put up prices of merchandise, labor, or land, you have had it. . . . . You might as well stand under Niagara's torrent and complain that you are kept dry by the predictions of the weather bureau of the government as live through the torrential and diluvian flood of standard silver coin that has drenched the whole financial world since silver was demonetized, and claim that the laws against free coinage have neutralized the inflating effect on prices which ought to ensue from its actual coinage in such unprecedented volume. All the silver combined which was coined in the United States or in the world during the century preceding the demonetization of silver was only about one seventieth part of the coinage of 15 years past."

(3) Regarding the fallacy of cheap money: "The public treasury has been getting all the benefit which could accrue from substituting treasury notes for gold and silver coin as the basis of our commerce for thirty years. It is this which now brings the treasury into the trough of the sea, where it cannot, even by the issue of new bonds at the rate of $100,000,000 a year, keep its gold in the treasury with which to hold up its treasury notes. When it ceases, they will be quoted at 50 cents on the dollar. The treasury is now the only debtor in the country that can be called on to pay coin, and it can only a few months longer pay gold coin. . . . As the apparent success of the greenback helped to impair the value of silver, to issue more greenbacks now as a means to raise the value of silver is to use the hair of the same dog to cure the bite."

(4) As to the "interest gorgon," it is responded that "rates of interest bear the proportion to the earnings of industry of one to four." "If, therefore, interest would eat up the value on which the principal is loaned in twelve years, wages would consume the capital that employs it in three years. The average annual increase or earnings on all the capital in the country working conjointly with all the labor is 24 per cent. Therefore there is no more danger that interest will swallow up wages than there is that one of the four sides of all the parallelograms in the world will swallow up the other three sides."

As to fallacy (5), it is replied "that

nobody desires that money itself shall be flexible, but that the volume or quantity of it in use should be flexible." "Merchants do not want yard-sticks of india-rubber with variable length, but what they do want, and ought to have the privilege of getting, is just as many yard-sticks as they need to use in their business." It is argued further that, if the government issued yard-sticks not otherwise obtainable and "made every yard-stick a promise by the government to exchange it for a yard of velvet," there would necessarily result a limit to the number of yard-sticks obtainable by merchants.

(6) As to the assertion that France has 600,000,000 francs "of legal-tender paper money in circulation," it is answered that, so far from this being the fact, she has not even "a cent's worth." "The only paper notes circulating as currency in France are the notes of the Bank of France, which has a branch in each of the eighty-seven departments of France. It is customary for the government to impart the quality of *cours forcé*, or legal tender, to the notes of the Bank of France in periods of public exigency (war), but to withdraw it on the return of normal conditions. . . . France is aided in maintaining silver by the fact that she has no treasury notes to maintain. She makes her payments, therefore, largely in silver, and the public creditor must take whatever proportion of his pay in silver she offers. But, if she were a bankrupt debtor, carrying tons upon tons of demand notes which she could not pay, her case would be different."

(7) As to fiat money, it is urged that "government never undertakes to supply the people with money except when it has no money itself. All that its money, therefore, can represent at any time is a hole left by an explosion." This point is elaborated, but we must get to the end.

(8) To "the 'greatness-of-government' fallacy" the answer is that, while the government receives and pays out annually about $350,000,000, "the bank clearings in 1892 were $61,535,493,426"; and that, "though they are now about $17,000,000,000 less, it is plain that the degree in which 'means of payment' are supplied by bank credit is sixty-fold the degree in which they are supplied by government payments."

Lastly (9), as to the decline in prices, it is retorted that "it is not all values that have declined, . . . but only the value of products," while "the value of the means of production, . . . including land, labor, and capital," has been advancing. This argument is also elaborated, but cannot here be further followed out.

The Silver Question.

A PAMPHLET of seventy-five pages, entitled "The Silver Question," has been sent to us from London. It contains an essay by George Jamieson, the British consul-general at Shanghai, to whom was awarded the bimetallic prize of £50 offered by Sir Henry Mersey Thompson for a paper which should point out most clearly (1) loss and injury sustained in England by the extraordinary rise in the value of gold during the last 20 years, consequent on changes in the laws regulating the use of gold and silver as money in various countries; (2) the tendency to the transfer of manufacturing industries to "silver-using countries" thus created, the result having been a rise in the silver prices of British manufactured articles and a "fall in their gold-price"; (3) that "this divergence" of gold and silver values must inevitably "lead to the ruin" of many British industries, and, by the substitution of cheap for "more highly-paid labor," "the throwing out of employment of tens of thousands of workmen."

This prize essay is supplemented by two others,—one by Thomas Holyoake Box, of Yokohama, the other by David Octavius Croal, of London, the whole being introduced by a preface written by Sir Henry Mersey Thompson, explaining the reason for offering the prize, and the reason governing its award. It will be possible only to indicate the leading points in the principal thesis.

(1) "Prices (wholesale) of nearly all commodities have fallen in gold-using countries. This fall coincided roughly, step by step, with the fall in the gold value of silver up to the end of 1892. Since that

date silver has fallen more rapidly than commodities, but the latter appear to be still falling." (2) "Wages, rents, and taxes in gold-using countries have not varied, or have varied only within narrow limits, due to temporary and local causes. Agricultural rents should, perhaps, be excepted; but these are subjected only to periodical revision." (3) "Retail prices (into which wages, rent, and taxes enter largely) have not fallen at all." (4) "Prices (wholesale) of all commodities in silver using countries have remained approximately steady during the period, and this whether the articles were produced in this country itself or imported. In the case of articles imported from gold-using countries, however, there has been, since the middle of 1893, a rise in silver prices, corresponding to the divergence between silver and commodities noted in No. 1." (5) "Wages, rent, and taxes have not varied in silver-using countries, or have varied only within narrow limits, and from causes unconnected with the relation of gold to silver." (6) "Retail prices in those countries have not varied, except in the case of articles purchased at retail in gold-using countries, which have risen in proportion to the rise in gold."

These propositions are fortified by the citation of a number of authoritative statistical publications. The causes assigned for alterations of prices are (1) "cheap ocean freights and a lessening of cost of production, through improvements in machinery, new chemical discoveries, and other scientific advances"; (2) the appreciation of gold, consequent upon the demonetization of silver; and (3) "an enlarged area of supply consequent on the relative cheapness of silver to gold. As silver prices in Asiatic countries have not risen, the produce of those countries can be laid down in England at almost Asiatic prices." The lowest cost of transport and production could not have affected prices more than from 3 to 5 per cent., and to the two causes—appreciation of gold and increased area of supply—are attributed the changes in prices that have marked the two last decades. "By the breaking of the bi-metallic link silver-using and the gold-using portions of the world parted company." In the gold-using portions prices began to adjust themselves to the mass of gold in circulation, and in the silver-using portions prices began to adjust themselves in relation to the mass of silver in circulation. If the portions thus separated had been "approximately equal in wealth, population, and extent of commerce," serious disturbances of prices would not have resulted. But, being unequal in these respects, the superiority being on the side of the gold-using portions, prices conform in different countries to that part of the gold, or of the silver, which "has found its way into their circulation." The increase in area of production has at the same time been a potent factor in the cheapening of produce, especially that of the cereal class.

Though Oriental competition has hitherto been confined to coarser grades of goods, there is no reason for supposing that it will remain so, provided the present status of gold and silver as money remains to stimulate such competition. The paper is a very strong argument in favor of bi-metallism.

The Aged Poor in England.

THE working of the English poor-law system as regards the aged poor is manifested in a report of the royal commission, which, while voluminous and elaborate, and loaded with statistics, *The Journal of Gas Lighting* (April 9) criticises as not containing "a single suggestion capable of being worked constructively with the object of removing a social condition which an awakened public conscience regards as a defect of our modern civilization." This criticism, however, is made against a shortcoming not unprecedented or altogether inexcusable, since to suggest a remedy for the existence of a class of "aged poor" except through a total reorganization of society would tax the profoundest of social economists.

The facts that the condition of this class is slowly improving under the present English poor-law system, and that it is gradually diminishing, appear to be established by the report, and are gratifying so far as they go. But the improvement and

the diminution inferred from the statistics are so slight that they seem scarcely more than an indication of the tendency which, to become very sensible in its effects, must continue through a long period.

It has been charged that drink, idleness, improvidence, and other vices are responsible for the existence of this class; but the report holds that this is true of only a very small proportion of workhouse inmates. "It is admitted that a certain number of deserving aged poor are to be found in workhouses for reasons other than sickness or infirmity; but the general effect of the evidence taken by the commission distinctly tends to the conclusion that they are few in number. Workhouse inmates generally are not fair examples of the working population. They are the failures, not necessarily all from vice, but from vice, slackness, want of backbone, which have in various degrees combined to make them the 'hard bargains' of the industrial army."

There is a minority report signed by five of the commissioners. Of the majority report *The Journal of Gas Lighting* says that it "is a series of cold douches for amiable visionaries who permit their fancies to carry them off into all sorts of dreams respecting methods for alleviating the lot of the aged and deserving poor. Many such suggestions are given, only to be dismissed as objectionable or unworkable on one score or another; while at the same time the existing system is admitted to be unsatisfactory in precisely the respects to which the suggestions refer. Hence it is not to be wondered at that the government and many other people are disappointed with the result of the inquiry: government, because the report does not indicate any lines upon which legislation calculated to receive the support of the labor vote might be instituted; and benevolent persons, because the report hardly assists anybody, with a shilling to spare for the help of the poor in old age, to see a way to its judicious employment for this purpose."

"The minority blame the majority for inadequately dealing with all that portion of the report which is concerned with the suggested substitutes for, or accessories to, the poor law. It is certainly remarkable that the efforts actually being made by employers of labor to help their aged workpeople to live without coming upon the rates are not even cursorily mentioned in the report."

The number of the commissioners—fifteen—is thought to have been too large. One of five members would have been better, and "such a commission might with advantage be composed of a statesman, a lawyer, a financier, an engineer, and a physician. . . . Human wit and capacity fail before the immensity and complexity of the problem as a whole," and "the policy of attacking it in detail by beginning on the nearer side" is commended. The gas industry in England has already adopted this policy, and of the results of its efforts a hopeful view is taken. "We trust that, so far as the gas industry is concerned, the practicability of preserving good honest workers from dying as paupers will be demonstrated before the world, for the guidance of whosoever may take up the task of formulating a constructive policy, which proved to be quite beyond the powers of the late commission. There is no mystery about this matter; it is done, and has been done for years, by many gas companies; but the duty should be recognized by many more."

Hard Times and the Railway Employees.

IN our department of Railroading for this month the effect of the hard times upon the great railway interests is revived with special reference to receipts, economies, dividends, and the enormous load thrown upon railway management by such commercial conditions. In the article therein reviewed ("Hard Times and the Railroad"—*The Peterson Magazine* for May) it is stated that "in June, 1893, there were 873,602 men employed on the railroads of this country. These men were divided almost equally between the active labor of administration and transportation and the conservative toil of reconstructing and repairing." As would be fairly inferred from Mr. Chauncey Depew's remarks, quoted in the review referred to,

the latter class of employees has felt the effects of the hard times much more severely than the former; yet a great many men in the lower grades in departments of administration and transportation have been "laid off," and have been practically idle for many months. Exact figures showing the number of men laid off in all grades are not supplied, but, bearing in mind that those employed in reconstruction and repair are the principal sufferers, some inferences can be made from a personal letter quoted in the article under review, and written by Mr. F. W. Arnold, secretary of the Brotherhood of Locomotive Engineers.

In this letter Mr. Arnold estimates that at least 3000 locomotive engineers, 5000 brakemen, 2000 conductors, and 1500 telegraphers, all belonging to railroad organizations, have been thrown out of work. He will not even attempt to estimate the number of those laid off who do not belong to those organizations. It is doubtless very large. The business of railroading has received a set-back that will long affect dividends, but there is a limit to such economy as the roads have been practising, and the time approaches when they will be forced into the employment of more men. Doubtless some of the roads have already approached this limit so nearly that it has become necessary to consider the lines on which they will first increase expenditure. This will be done cautiously at first, but with increasing business and good crops full resumption on the old basis cannot be delayed long.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Industrial Sociology in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

*30832. Malignant Effects of the Free Silver Delusion. Edward Atkinson (Eng Mag-June.) 3000 w.

†30945. The Free Trade Friction. A. Ewbank (*Ind Engng*-March 9.) 2400 w.

†30987. The Historical Aspect of the Monetary Question. Alexander Del Mar (*Fort Rev*-April.) 3500 w.

†30988. The China Problem and Its Solution. E. T. C. Werner (*Fort Rev*-April.) 6400 w.

*31011. Is Bimetallism a Fad? (*Bank Mag of Aust*-March.) 1500 w.

*31032. Report of the Royal Commission on the Aged Poor (*Jour Gas Lgt*-April 9.) 2000 w.

*31108. Belgian Trades Unionism as Viewed in the Light of French Experience. J. Lecocq (*Col Guard*-April 11.) 7000 w.

31199. The Silver Problem. Green Majors (Min & Sci Pr-April 20.) 1600 w.

*31269. Peace in China and British Trade (*Trans*-April 19.) 1500 w.

†31274. Our Situation Viewed from Without. Goldwin Smith (N Amer Rev-May.) 5800 w.

†31276. The Income Tax. I. The Decision of the Supreme Court. George S. Boutwell. II. The Spirit of the Tax. Plain Speaker (N Amer Rev-May.) 8000 w.

†31304. Business, Friendship, and Charity. Logan G. McPherson (Pop Sci M-May.) 6200 w.

*31306. The Social Pressure in Politics. William B. Chisholm (Am Mag of Civ-May.) 2900 w.

*31307. Civilization and the State. A. A. Johnson (Am Mag of Civ-May.) 5500 w.

*31310. American Trade Prospects in East Africa. Charles J. Zingg (Am Mag of Civ-May.) 1500 w.

*31313. Farmers and Taxation. James Middleton (Am Mag of Civ-May.) 4000 w.

*31315. Should Church Property Be Taxed? William H. Laird (Am Mag of Civ-May.) 1400 w.

*31345. The Petroleum Panic. Editorial (*Irm*-April 20.) 1500 w.

31379. The Oil Situation. Editorial (Pro Age-May 1.) 800 w.

*31398. Evidence of the Control of Industries by Workmen Shareholders (*Jour Gas Lgt*-April 23.) 2400 w.

*31405. The Present Condition of Russian Industries (*Bd of Tr Jour*-April.) 700 w.

*31409. Tariff Changes and Customs Regulations.—Russia, Norway, Sweden, Switzerland, France, Belgium, Spain, Portugal, Italy, Cyprus, United States, Mexico, Ecuador, Peru (*Bd of Tr Jour*-April.) 8000 w.

*31512. Trade Possibilities in China (*Eng*-April 26.) 1500 w.

*31528. The Argentine Republic.—Railways and Harbors (*Trans*-April 26.) 2000 w.

†31573. The State and Dwellings of the Poor. Frank Buffington Vrooman (Arena-May.) 7000 w.

†31597. Coin's Financial School Answered (Bank Mag-May.) 12000 w.

†31598. A Lesson from England's Banking Legislation. Winthrop M. Daniels (Bank Mag-May.) 4000 w.

Serials.

30453. Bimetallism vs. the Single Standard. L. Bradford Prince (Am Mag of Civ-Began April—2 parts to date— 30 cts. each).

We supply copies of these articles. See introductory.

MARINE ENGINEERING

Steam Pipes.

THE numerous failures of steam pipes on shipboard are calling the attention of engineers to the underlying defects of these pipes and the necessity of finding a remedy. It is true that the large majority of failures are of minor importance and can readily be repaired; nevertheless, they give trouble, and add to the ever-increasing burdens of marine engineers. Some break-downs of steam pipes are however, so serious as to endanger life, and even to hazard the destruction of the vessels on which they occur. A failure of a steam pipe may temporarily cripple a ship as much as the breakage of a propeller shaft.

In a paper read before the Institution of Naval Architects by Mr. J. F. Milton and printed in *Engineering* (April 5) he directs attention to a growing disfavor on the part of marine engineers toward copper as a material for steam pipes. He gives a list of eight ships in which cast-iron replaced copper for this purpose, and in which the cast-iron pipes were subjected to a service of from 7 to 25 years, the average term of service for the ships named having been over 18 years. He thinks the selection of copper for marine steam pipes in the early days of marine engineering was influenced by its ductility and freedom from corrosion under the action of steam.

"It must be remembered that the advance of engineering of late has not only increased the steam pressure used,—and, therefore, the temperature also,—but engines are, in general, of much greater size and power than those used years ago. The steam pipes now, therefore, are, as a rule, larger in diameter, much thicker, and are subject to greater changes of temperature and expansion, &c., than formerly. These all make the pipes so much stiffer, or more rigid, that with many pipes, even when made of copper, their rigidity is so great that their yielding or altering form cannot be relied upon to relieve expansion strains, which have, therefore, to be provided for in the same way as they would need to be if the pipes were made of cast-iron." Seamless copper pipes are now made for steam purposes, and have met with some success. But trouble has also been experienced with seamless pipes.

Speaking of tests of pipes made by the Elmore process, and also of seamless drawn pipes, it is said that these tests were made with unannealed pipes. The pipes in this condition might show a high character for strength, but "this is a condition in which they could not be used for steam-pipes on ship-board. After annealing, the behavior of these pipes is not much different from that of ordinary copper pipes of equal thickness. Copper pipes are now frequently reinforced by iron bands at short intervals or by wrappings of wire or wire rope. Of the three remaining materials out of which steam-pipes can be made—cast-iron, wrought iron, and steel—Mr. Milton favors wrought iron. Whatever material is used, the importance of provision for expansion and drainage of the pipes must not be overlooked.

"Concurrently with the trouble of providing for expansion, &c., with thick and large pipes, there arises also a difficulty in manufacturing them. The usual method of making pipes of large diameter is to make them, both bends and straights, from copper sheets, the straights, except in very large pipes, having one seam along the entire length, the bends having two seams along the sides, the saddle and back pieces being each worked up from one sheet. The seams are invariably brazed, the edges of the copper being thinned down to form a scarf. Now, the difficulty of satisfactorily brazing a joint of this description increases rapidly with the thickness. The heat has necessarily to be applied from the outside, and has to pass through the thickness of the metal to reach the brazing solder, and thus the risk of overheating the copper on the outside, and consequently burning it,

is much greater with thick than with fairly thin copper. There is also a further danger of deoxidizing the copper, both in the brazing and also in the previous annealings to which the copper has to be subjected. Amongst some of the earliest of those made some serious longitudinal defects (probably arising from a local defect in the original ingot being drawn out lengthwise in the manufacture of the pipe) caused them to be looked upon with a certain amount of suspicion, besides which the great difficulty of making satisfactory bends with these large pipes has no doubt had some influence in preventing their more general use. Regarding provision for expansion of pipes, whether of copper, iron, or steel, a point sometimes lost sight of is that it is not sufficient to provide a faucet joint in a straight length of pipe, but provision must also be made to anchor the ends of the length of pipe for the expansion for which provision has to be made, and so compel the movement of expansion to take place in the part provided for it; otherwise the end pressure on the pipes, amounting to several tons in all but the smallest pipes, will cause the joint to slide in the wrong direction. This has occasionally been overlooked in pipe designs. It is always difficult to provide for the expansion of large bends without producing excessive strains, so that, as far as possible, pipes should be made straight." The welding of flanges to sections of piping is preferred to screwing the flanges on the pipes.

Induced Draft Versus Forced Draft for Marine Boilers.

By "induced draft" is meant a draft produced by exhaust, as distinguished from one caused by increased pressure in the stokehold. Both result in increasing the difference between the atmospheric pressure in the furnace and that in the stokehold, and at first thought one might suppose the effect for a given difference of pressure ought to be the same, no matter how produced. But such a conclusion is not warranted by facts. The system of induced draft is now attracting much attention, and by some, among whom is M. W. A. Martin (*Industries and Iron*, April 5), it is regarded as superior to forced draft. The article referred to is an abstract of a paper read before the Institution of Naval Architects (April 13).

"The locomotive type of boilers has been largely adopted for marine purposes, but the system of working this kind of boiler has been reversed with very unfavorable results." The author, having made a large number of experiments in steam generation with all classes of boilers, was enabled to place before the meeting some particulars. "Although it has been sometimes maintained that, so long as you create a difference in pressure between the air in the chimney and that in the stokehold, it matters not whether you exhaust from, or blow to, the fire, yet it will be seen, upon closer examination, that the characteristics of forcing and inducing are widely different. The forcing system is advantageously used for blasting down ores, and for iron foundry purposes, where the metal can fall below the blast as soon as melted; but it is an unsuitable process for puddling, reverberatory, and reheating furnaces, such as are used in iron and armor-plate making, where volume and steady heat are required. For these purposes exhaust or induced draft is used.

"The marine boiler exposes a large mount of surface to be acted upon, and it is of primary importance that the heat should be evenly distributed over it, and not concentrated on particular parts. To effect this, the draught must have perfect control over the gases generated in the furnaces, as on the proper application of the draught the whole working of the furnaces depends. It is a tendency of the forced draft system, as used in the navy, to concentrate and localize the heat." There is thus seen to be an effect of distribution of the air in the furnace from induced draft, unattainable by the system of forcing. Mr. Martin gives tabulated results of a series of trials to test experimentally the truth of these propositions, made by him under permission of the admiralty, on H. M. S. Gossamer. A series of trials had been previously performed

on H. M. S. Polyphemus, and the Gossamer experiments were arranged to test more crucially the results obtained on the Polyphemus. A series of experiments had before been carried out with forced draft on the Gossamer, and on both the vessels forced draft was experimentally contrasted with induced draft, with careful record of the results. On the Gossamer "there are two boiler rooms identically similar, and two boilers of the locomotive type in each. The forward boilers were selected for the application of the induced draft system, which was fitted in the uptake forward, leaving the stokehold in its original condition, with the air locks and other forced draft fittings unnecessary for induced draft. The air locks and hatches, however, were left open during the trials, and only in this respect was there any difference in the working of the two systems."

Not only was the power produced on this ship by induced draft, as shown in the tabulated statements, far in excess of that produced by forced draft, but a superior economy of fuel also resulted. A curious effect noted was that, when urging the boilers toward their highest capacity with forced draft, they primed very seriously, whereas they could be urged to a much higher evaporative capacity by induced draft, giving dry steam all the time. Injury to the boiler is less liable to occur with induced draft. Mr. Martin's theory regarding this comparative immunity is that the partial vacuum produced protects the ends of tubes, etc. The dryness of the steam, when an induced draft was used, is accounted for by the greater uniformity of temperature throughout the boiler. "Another important point in favor of induced draft is the saving of weight in comparison with forced draft. The iron work involved by the latter for casing and air locks in a first-class battleship is about 19 tons. This is dispensed with by the induced-draft system. The economy of fuel effected also tells in connection with weight."

Another important point is that "the principle of induced draft renders it quite independent of the length of the funnel. In fact, the funnel may be dispensed with altogether, so that, in the case of a war-vessel, if the funnel were shot away in action, it would not in any way affect the facility of steaming."

"It is remarkable that, while the forced-air system results in diminishing economy as the blast is raised, and there is a maximum pressure beyond which it is difficult to work at all, the induced system, on the contrary, gives an increased draft with no limit but the convenience of obtaining high speed of fan. The gases, being drawn through the tubes instead of being forced, are more perfectly consumed, and there is no lodgment of ashes in the tubes. So regular is the process of combustion that the quantity of coal consumed does not increase in anything like the same ratio with an augmented rate of working."

The Launch of the St. Paul.

THIS splendid ship has been successfully floated from William Cramp & Son's shipyard. She is the mate of the St. Louis, also built in the same yard. The completion and putting into commission of these great ships is an event in marine engineering too important and significant to be passed without general comment in all publications devoted to naval construction throughout the world. The following dimensions of the vessel given below are taken from *Seaboard* (April 11), which also publishes an engraving of the ship as she appeared on the stocks before launching.

The engines of this ship are the most powerful quadruple expansion engines ever built, and this fact alone is sufficient to arouse the interest of marine constructors, as it will test the principle of quadruple expansion on a scale never before attempted. "Steam is to be supplied by six double-ended boilers, each 20 ft. long by 15 ft. 7½ in. in diameter, with 39 furnaces, making a total grate surface of 830 sq. ft. and a heating surface of about 30 000 sq. ft. In addition to the main engines, there are forty-nine auxiliary engines in each ship, being used for all kinds of purposes."

The outfit of the ship will be as complete and elegant as money can purchase. A number of the state-rooms are suites of

three apartments, consisting of a parlor, bedroom, and bathroom. The steerage furnishes accommodation for 900 passengers. The profusion of lavatories and bathrooms is a feature of the design which will be highly appreciated by passengers. Four powerful dynamos will supply current for electric lighting, which will be wholly incandescent. A system of forced ventilation supplies pure air to all parts of the ship. Provision is made for warming the air thus supplied in cold weather, and also for individual control of ventilation by occupants of state-rooms. The state-rooms are furnished with side-lights and automatic valves that exclude water.

This vessel accommodates eighteen hundred people,—passengers and crew. She could transport the population of many an American village with all its moveable effects in a single passage. "To insure the safety of this great number while on the sea every device of known value has been applied. The bulkhead divisions have been so constructed that with any two, or even three, compartments flooded the vessel would remain perfectly seaworthy. Complete boat accommodations will also be provided for every one on board. Another great advantage in these American liners is that they are fitted with two sets of engines, each driving a separate screw. The engines are in two separate compartments divided by a water-tight bulkhead, and the boilers are in separate compartments completely cut off from each other, so that the vessels might come into collision by being struck on the bulkhead, and could have a break-down in their machinery, such as may occur in any ordinary ship, and still be navigable and thoroughly safe and seaworthy. In order to avoid waiting for high tide for several hours outside the harbor bar, either at New York or on the other side, the St. Louis and St. Paul have been designed for light draught. Proper immersion for the screws will be obtained by the use of water ballast, and before reaching the bar this water ballast will be pumped out and the vessel's draught greatly lessened. This is also a double precaution against injury by grounding." The dimensions of the St. Paul are: "Length between perpendiculars, 535 ft.; length over all, 554 ft. 2 in.; extreme beam, 62 ft. 9 in.; depth from first deck to flat keel, 42 ft. 4 in.; depth of hold for tonnage amidship, 23 ft. 2 in.; height of bow above water line, at load draught, 39 ft.; number of decks, 5; number of water-tight compartments, exclusive of ballast tanks, 12; gross register, 10,700 tons; load displacement, 15,600 tons; dimensions of main saloon, 109 ft. 4 in. by 46 ft.; dimensions of second cabin, 39 ft. 6 in. by 56 ft.; seating capacity of main saloon, 322; seating capacity of second saloon, 208; berthing capacity of steerage, about 900."

The Quickest Voyage from China to New York.

THE recent trip of the bark Amy Turner from Hong Kong to Chesapeake Bay in 88 days recalls to Captain J. M. Cavarly, in *Seaboard* (April 4), a still more remarkable trip made by Captain Robert H. Waterman in the ship Natchez in 1845, wherein the trip from Hong Kong to New York was made in 78 days and 6 hours. In 1846 the same captain made the trip in the clipper ship Sea Witch in 82 days "against the strength of the south-west monsoon." In 1847, "in the same vessel, with a fair monsoon, he made the trip inside of 76 days,—probably the shortest time ever made by a sailing vessel between the two ports." The entire distance sailed is close to 14,000 miles. The average daily distance run is, therefore, something more than 186 miles. The article is illustrated with a portrait of Captain Waterman, and an abstract of the voyage in the Natchez in 1845, compiled from the log-book, is appended.

Controlling Valve for Steering Engines.

THE steering engine is a noisy device when the work it does is considered, and it has extremely low efficiency as a motor. *The Marine Engineer* May 1, in describing a new controlling valve for steering engines, explains the small efficiency by the fact that at mid-position of the rudder,—the position of least load,—just as much steam is inducted as at extreme helm positions when the load is greatest. The engine is, therefore, for the greater part of the time

exhausting high-pressure steam. The new controlling valve appears calculated to lessen both the noise of the machine and the waste also.

A valve arranged over a double-ported seating, is fitted on the slide case of the engine just above the ordinary controlling valve. This valve is automatically operated in conjunction with the travel of the tiller, in such a way that more steam is admitted to the engine as the helm goes over and the load increases, while, when the helm is at or near the mid-position, very little steam is admitted to the engine, only just such a quantity being allowed to pass as will drive the engine at a sufficient speed for efficient steering. The valve is operated by a bell crank lever, one arm of which is connected to a nut, worked by the helm indicator, It is claimed that this device can be fitted to existing machines. Its advantages seem undeniable.

THE TECHNICAL INDEX--1895.

Current Leading Articles on Marine Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

30862. The St. Paul Launched. Ill. (Sea April 11.) 2800 w.

30867. Experiments in Navigation With a Compressed Gas Motor. Ill. From La Nature (Sci Amer Sup-April 13.) 1800 w.

30882. The Jurisdiction of the Secretary of War Over Navigable Waters. Editorial (Eng News-April 11.) 2200 w.

*30916. Remarks on Steam Pipes. J. T. Milton (*Engng*-April 5.) 4000 w.

*30928. Induced Draught for Developing the Power of Marine Boilers. W. A. Martin (*Ind & Ir*-April 5.) 1200 w.

30977. School for German Marine Engineers and Machinists. From Consular Reports (Eng-April 13.) 1000 w.

31016. Sickels' Steam Steering Gear on the "Pensacola." I. McKim Chase (Am Mach-April 18.) 1000 w.

31026. How to Equalize Protection and Promote Shipbuilding. Editorial (Sc A-April 18.) 1600 w.

31027. The Launching of the New American Steamer St. Paul. Ill. (Sci Amer-April 20.) 600 w.

*31098. The Elements of Force in a Warship. Review and Discussion of Paper by P. H. Colomb (*Engng*-April 12) 5000 w.

*31099. Discussion of Paper by J. T. Milton, on "Remarks on Steam Pipes" (*Engng*-April 12.) 4200 w.

*31100. Review and Discussion of Paper by George Rickard on "Light Draught River Steamers" (*Engng*-April 12.) 2800 w.

*31101. An Aluminum Torpedo Boat. Ill. A. F. Yarrow (*Engng*-April 12.) 2000 w.

*31103. On Solid Stream Forms, and the Depth of Water Necessary to Avoid Abnormal Resistance to Ships. D. W. Taylor (*Engng*-April 12.) 3000 w.

*31114. Engine Room Practice at Sea. W. M. Binny (*Marine Eng*-April.) 2800 w.

*31132. Water Supply on Board Ship (*Trans*-April 12.) 1000 w.

31170. Ocean Tramps (Mnfr & Builder-Dec.) 1200 w.

31190. Triple Screws (Sci Amer-April 27.) 900 w.

31193. The Magnetic Needle. Vaughan Cornish (Sci Amer Sup-April 27.) 1900 w.

31232. A Fast Lake Steamer of 1860.—The City of Buffalo (Eng-April 27.) 700 w.

*31270. The Water-Tube Boiler Question (*Trans*-April 19.) 3500 w.

*31294. On the Vibrations of Ships and Engines. Ill. A. Mallock, with Discussion (*Engng*-April 19.) 10000 w.

31297. The Waste and Supply of Shipping. Editorial (*Engng*-April 19.) 1800 w.

*31300. On Vibrations of Higher Order in Steamers, and on Torsional Vibrations. Otto Schlick (*Engng*-April 19.) 3200 w.

*31333. On a Method of Preventing Vibrations in Marine Engines. Mark Robinson and H. Riall Sankey (*Eng*-April 19) 3500 w.

*31335. The Vibrations of Steamships and Engines. Editorial (*Eng*-April 19.) 1200 w.

*31346. Engineers in the Navy. Editorial (*Prac Eng*-April 19.) 2000 w.

31386. The Lighthouse Supply Steamer, Armeria. Ill. (Sc A-May 2) 900 w.

31390. The Battle Ships Magnificent and Charlemagne—A Comparison. Ill. (Sci Amer Sup-May 4) 650 w.

Serials.

16636. Marine Engine Design. Ill. (*Mech Wrld*-Began Oct. 6, 1893—23 parts to date—30 cts. each).

30466. Protection to Agriculture and Shipping—The Lubin Proposition Considered by Our Shipbuilders (Sc A-Began March 28—2 parts to date—15 cts. each).

30482. Large Ships of Cellular Type. Ill. William Bell (Am Ship-Began March 28—Ended April 18—3 parts—15 cts. each).

30576. Turret-Deck Cargo Steamers. S. O. Kendall (*Ind & Ir*-Began March 22—4 parts to date—30 cts. each).

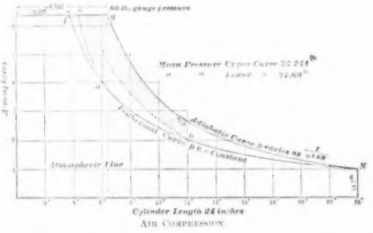
We supply copies of these articles. See introductory.

MECHANICAL ENGINEERING

Compressed Air.

Of the compression of air by power-driven compressors, Mr. W. H. Booth makes some sensible remarks in *American Machinist* (April 18). As to compression of air with and without cooling, he thinks that, if any one goes into a study of these methods, "he will come out of it with the conviction that air-compression is an operation that requires time, owing to the difficulty of cooling the air with rapidity during compression." "Overlooking for the moment the mechanical advantages of air-compressors built on the direct-acting principle, it would appear that direct action is not a consistent practice, for slow movement is bad for the economy of the steam cylinder, and good for the air cylinder, and some indirect connection which should allow the steam piston to travel much faster than the air piston is clearly indicated by the physical conditions of the problem."

We have reproduced a diagram used by Mr. Booth in illustrating the effect of stage compression with intermediate cooling. In it are drawn "two curves marked respectively 'isothermal' and 'adiabatic,' the first being the pressure curve resulting from the compression of air from atmospheric pressure to 80 lbs. gage pressure at so slow a rate of speed as will allow the air to become cooled as quickly as it is compressed, the second being the curve due to the compression of the air, the temperature increasing as it is compressed, and losing no heat by radiation or cylinder conduction. Of course these curves are both impossible in practice. They are the extremes between which every compression curve will lie. Let us now suppose that the piston is at the end of its stroke, and moves suddenly to the middle of the cylinder; and the adiabatic curve is followed to *a*. There the piston waits while the air cools, and the pressure falls to *b* on the isothermal curve. Thence the piston moves forward half the remainder of the stroke, and the curve *b c* is traced by the indicator pencil; the piston again waits until the temperature falls, and the pencil drops to *d* on the isothermal. Completing its stroke, the piston forces the air again to give the curve *d e*. The diagram is thus made up of the three short curves, *n a*, *b c*, *d e*, joined by the vertical lines of cooling *a b*, *c d*.



"Though inclosing a larger area than the isothermal curve, yet the treble curve area is very much smaller than the area inclosed by the adiabatic diagram, and the difference is all so much power economy. Though this system of piston movement and stoppage is not a practicable system, it points to a system which is practicable, and which is productive of economy wherever its principles are followed out. I refer, of course, to the compound system, which seems to be eminently suited to the process of air-compression. In place of the three-step diagram of the illustration, there would be three cylinders in series, each forcing air to an intermediate receiver exposed to external cooling influences. In passing through such receivers the air would be deprived of the additional temperature it has acquired by each step in the series of compression, and though, of course, there is no added complication of extra cylinders, these can be all placed tandem fashion on one rod, and the same mechanical advantages are secured as in the compound steam engine, such as reduced stresses on the crank pins or rods, reduced periphery of leakage on the highest pressed piston, etc., all which, with the

saving of power, make compound air-compression fully as reasonable as compound steam-expansion."

As to the curves called "pressure curves" by Mr. Booth, it may be added that they are both pressure and temperature curves. In drawing these curves the abcissas represent volumes, and are mathematical functions of both pressure and temperature. Of cooling air in the cylinder during compression no quick and perfect way has yet been devised. Injection of water in the form of spray has not been abandoned, as Mr. Booth thinks, on account of its saturating the air with moisture. It is rare, even without the use of this method, that ordinary air contains enough water to saturate it after compression to 3 atmospheres and cool it again to its original temperature. There are other practical objections to the use of water in air-compressors. It is not always practicable to obtain a supply of water sufficiently free from abrasive particles, and appliances for spraying the water into the cylinder and separating and trapping it out afterward add considerably to complications and cost. Stage compression, with intermediate cooling in surface coolers, is the most rational way, and only in the first cost of apparatus is it any more expensive. The better results more than compensate for increase of first cost in any case where the amount of work is moderately large.

"The diagram corresponds with a cylinder of 24-in. stroke. The space occupied by the heated compressed air is seen to be 6.392 in. of the length of the cylinder, —that is to say, when the piston arrives within this distance of the end of its stroke, the air will raise the valve leading to the reservoir, which is supposed to carry 80 lbs. gage pressure. If, however, the air could be cooled as fast as it is compressed, the space occupied would only be 3.725 in. In the first place the piston must move against the reservoir pressure 2.667 in. more than in the second case. The mean pressures are, respectively, 36.264 lbs. and 27.69 lbs.,—a ratio of 100 to 131 very nearly.

"If, now, the cooled air were allowed to expand again from the point f, without receiving heat, the curve of the diagram would, being adiabatic, fall below the isothermal curve of the illustration. Hence it is obvious that in compressing air, if we compress along the curve $N g$ and expand again along the curve f N, the air having cooled from g to f in the pipes, we shall lose enormously. We have, therefore, to endeavor as far as possible to compress from N to f, then add heat, and expand from g to where? Not to N, if we can help it, because this means that we have only heated the air and not the cylinder; we must try to expand down a curve which rises above N by continuing to add heat to the cylinder, just as we add heat to a steam cylinder by means of a jacket. By so doing we can cut off earlier on the working stroke," and this means economy, precisely as an early cut-off with high pressures means economy in steam engines.

Hydraulic Air Compression.

A SYSTEM (said to have been patented) for the hydraulic compression of air is described and illustrated in *The Canadian Engineer* for April. The system is based upon a long-known and anciently-used principle, and the apparatus, as described, is nothing more or less than a trompe,—an apparatus which came into use in the south of France about 200 years ago for blowing forge-fires, and which at one time was widely employed for this purpose. There are, however, some details in the new apparatus upon which a patent could have been obtained; and perhaps in the application of the air compressed in this way as motive power for tram-cars there may have been some patentable features. If this be true, the article under review does not intimate what they are. It asserts, however, that the system as a whole is "fully covered by patents and is controlled by a joint-stock company." As to the probability that any very broad patent claims upon this alleged invention could be sustained, should the patent ever be subjected to litigation, those familiar with the trompe will be able to form an opinion after perusing the description which follows.

"Briefly stated, the air is compressed by the direct action of falling water without

the aid of any moving machinery, and practically without expense for maintenance or attendance after installation. By this system any fall of water varying in working-head may be utilized, and any pressure required can be produced and uniformly maintained up to the capacity of the water power, delivering the compressed air at the temperature of the water, and in a drier state than is possible by any known means of compression, thereby avoiding all loss by condensation or shrinkage by cooling of the air after compression. The water may be conveyed to the compressor by means of an open flue, or through a pipe supplying a tank or stand pipe round the head-piece of the compressor, where it can attain the same level as the water in the dam or source of supply. Around the head-piece are placed a large number of small horizontal air-pipes, drawing their supply of air through larger vertical pipes, which extend above the surface of the water and open to the atmosphere. As the water enters the down-flow pipes, it draws in the air in the form of small uniform globules, which, becoming entangled in the descending water, are carried down to the receiver at the bottom of the pipe, compressing the air by the pressure of the water surrounding these globules until they reach the point of separation. This pressure is maintained so long as there remains any air in the receiver."

These small induction air-pipes appear to be a new feature, and they doubtless add much to the efficiency of the apparatus. "The receiver is sufficiently large in diameter to allow the air to rise to the surface of the water therein, from whence it is taken through the air-pipe for transmission to be utilized as power or for other purposes. The water, being kept down by the pressure of the air, is forced out through the bottom of the receiver and up the shaft around the down-flow pipe to the tail race level." There are also some details of the receiver that doubtless aid in the operation of this improved trompe, for such it must be considered. Considerable stress is laid upon the fact that the compressed air contains less moisture than the air before compression. This fact, however, is incorrectly stated in the description, which says that the air in the receiver after the compression is *drier* than before. As a matter of fact, air compressed while in contact with water is always saturated (or very nearly so) with moisture after the compression, and is therefore wet air. It holds all the moisture it can hold at the temperature of the water with which it has been brought into contact, and if, while the pressure is maintained, the temperature be lowered, it will immediately precipitate some of this moisture. The fact remains that, nevertheless, it may contain less water than before compression. Dryness of air depends upon temperature and pressure, not alone upon upon the pressure. Hot air containing a given amount of water may be much drier than cold air containing less. Air taken from the receiver of this apparatus, and used in a motor without reheating, will as surely drop its moisture in exhaust ports as though it were compressed in an ordinary compressor with injection of water, and in this respect there is not the slightest advantage in the use of the trompe. It is rather surprising that, in the face of what is now so generally known about the behavior of compressed air in motors, such a claim should be publicly made. There are other claims that appear absurd, but let these pass. It appears to us extremely doubtful that a system long since obsolete can be thus revived by a few slender modifications, none of which appear to be essential to the application of the principle that entrained air can be carried down by a stream of water in a pipe, and separated under pressure in a receiver below. The manufacture of power-driven air-compressors is not likely to suffer from this scheme.

Raising Water by the Air-Lift.

IT has long been known that a suction pump could be made to raise water considerably higher than the height of a solid column of water in a tube balanced by atmospheric pressure, by the simple device of allowing some air to leak into the suction pipe. This is explained by the fact that a column of mixed water and air ves-

icles is lighter per foot of height than water unmixed with air, and hence the atmospheric pressure upon the surface of the water wherein the suction pipe is placed can lift a higher column of the former than of the latter. It does not seem to have been known till recently that water or any other liquid could be raised effectively through an open vertical tube inserted in a mass of the liquid, by forcing air into the open end of the bottom of the tube, and that the farther below the liquid surface the lower open end of the tube is placed the greater and more powerful will be the discharge, provided the injection of air is proportioned rightly to the work to be performed.

The action, after the air enters the lower part of the tube, is simply due to gravity. The mixed air and water is lighter than the solid water, and is therefore pressed upward by the weight of denser water outside of the tube, precisely as though it were a cylinder of cork. This system of raising water, which has latterly come into extensive use, and which is known as the Pohle air-lift (named after the inventor), has proved to be one of the most important of modern innovations in the field of hydraulic engineering. *The Engineering Record* (April 20) has commenced a series of articles upon the subject, the first giving an account of the circumstances that led up to the invention and naming a considerable list of installments where the invention has been advantageously applied. The article asks for explanations of the action of this pump from hydraulic engineers, and doubtless there will be more than one theory advanced. This action seems, however, not at all mysterious to us.

If a series of cork plugs could be successively placed in the bottom of a tube inserted in a mass of liquid, and could freely move upward, dividing the column within the tube into alternate strata of water and cork, the action would be exactly the same as when the air plugs are inserted, and the work of the lift (disregarding all losses between the prime motor and the bottom of the tube) would be exactly what is required to force the continuous rank of corks down from the surface to the point of entrance. The system seems to be a very economical and effective way of applying power for raising water, but there is nothing occult in the principle of its action.

Of course it follows theoretically that the deeper the lower end of the tube is submerged, the higher the mixed column of water and air can be raised above the surface. In practice, however, there are limitations to the application of the theory. It is not advised to exceed 150 ft. at a single lift; but, by delivering the lifted water into stand pipes at successive elevations and supplying each with an air-lift, water may be raised from any level to any other accessible level. If the original source of supply be a shallow stream, not admitting of deep submergence, the initial lift will be short, but by increasing the depth of the successive stand pipes at different elevations deeper submergence and higher lifts may be obtained, till the practicable limit of a single lift is reached. One of the most important points in connection with this system is the reason (or reasons) for the practical limitation of the lift, since theoretically, with an unlimited submergence of the lower end of the tube, there would seem to be no assignable limit to the lift. The system may easily be exemplified experimentally by any one. A piece of straight glass tubing of from ⅜" to ½" calibre, a smaller blowing-tube, one end of which is bent so that it can be put up into the bottom of the straight tube, and a water-pail are all the apparatus needed. Place the straight tube down in the water, pass the bent end of the blowing-tube down into the water and up into the open end of the straight tube, blow into the upper end of the blowing-tube, and mixed water and air will be lifted in the straight tube.

Centrifugal Pumping from Pits.

THE use of centrifugal pumps in California valleys in raising water for irrigation, having led to frequent inquiries as to the details of the system employed, Mr. Byron Jackson, of San Francisco, in *Industry* for April, supplies the desired in-

formation by an illustrated description, of which, in this review, we can give only an outline.

First pits about 12×6 ft. are sunk from 40 to 80 ft. below the surface and lined with 2×12 in. red-wood planks, "half notched at the corners so as to require no framing." A temporary pumping-plant is used to keep the pits free from water during the processes of sinking them below the standing level of the water in dry weather. Then artesian wells are bored from the bottoms of the pits to depths of from 50 to 200 ft., and lined with riveted pipes.

The centrifugal pumps are mounted on platforms at the bottoms of the pits; or, in some cases, "the platform is suspended so that it can be raised or lowered," as the level of the water in the pits rises or falls. The suction pipes feed into the tops of the pumps, which are driven by vertical shafts taking power from an engine by belt. "The suction pipes enter on top of the pump, as shown in the drawing, and extend down into the tube wells 35 ft. or more, so that the water cannot fall below the intake end. If the supply is less than the pumping rate, no air can enter, and the charge of water does not run back.

"The water is taken in at the top of the pump for several purposes. It permits the well-pipes to be withdrawn vertically, and enables the pump-shafts to be sustained by the action of the water. The weight of the pump-impeller and driving shaft—sometimes a ton—are balanced by the water-thrust, and the shafts therefore run in equilibrium. The proportions, deduced mainly by experience, are unusual. The up-take pipe has usually four times the area of the pump-discharge nozzle, and the aggregated area of suction pipes is larger still, so that the flow is reduced to 3 or 4 ft. a second. For a head of 100 ft. the velocity of the impellers is about 90 ft. per second at the periphery, and the revolutions from five hundred to eight hundred per minute, according to the diameter of the impeller. Formerly these pumps were made compound, so as to run at a lower velocity, but the simple form now prevails even for heads exceeding 100 ft. The supply raised for orchards is from 600 to 1500 gallons per minute, which forms quite a stream, and as much as can be managed by a distributing force of men who direct the water over the ground."

The pumps are charged by injectors. Ascent and descent to and from pumps is accomplished by vertical ladders. "The water, as it issues from the main pipe, is a beautiful sight,—as clear as crystal, and often charged with gas, so as to present a silvery appearance; but it commonly carries in suspension a good deal of fine gravel that can be heard impinging against the sides of the pipes by applying one's ear to the outside. A person not experienced in the matter does not realize what 1500 gallons a minute means. It is a small river, and seems out of all proportion to the diminutive little machine that impels it. The efficiency attained in these plants is from 40 to 60 per cent., which is far in excess of what would be inferred; but the fact is that the machinery is commonly of a high class, with no makeshift appliances anywhere. Cords of wood and inches of water are pretty well understood among the orchardists and valley farmers, who are usually a well-educated class of people, often well versed in hydraulics and motive power." Mr. Jackson states that no other kinds of pumps will answer for this work. The fine gravel which is brought up by the water would in a short time destroy any form of piston or plunger pump. The first cost of a centrifugal pump is only about half as much as that of a piston-pump of from one-eighth to one-sixth the same delivery. The "relative investment is as twelve to one, considering the pump alone, and for the whole plant together there is a saving of at least one-third." Moreover, "there is no type of piston pump that would not fill up the pits and prevent access to the wells." The method is explained to be the outcome of 20 years' experimental evolution, and to be in every way satisfactory.

The Sickels-Corliss Controversy.

As regards the merits of this controversy, we think that, after perusal of an article by Mr. W. F. Durfee in *American*

Machinist (April 11), any unprejudiced mind capable of weighing evidence will come to the conclusion that Frederick E. Sickels conceived the first practicable apparatus for lifting, tripping, and regulating the closing of the valves of steam engines; and George H. Corliss, notwithstanding the allegations that he got the idea of his inventions from the study of Sickels's cut-off device, used nothing that Sickels had secured by patent, while his cut-off was a real and marked advance on Sickels's invention.

The possibility of such a movement had been seen by others, and unsuccessful attempts at doing the same thing had been made. It appears that Sickels claimed less in his application than he was entitled to, and that he failed to discover this weakness till the litigation between the two men was commenced. The attempt of either party to prove that the other had not invented the thing he patented failed, and the patents of both stood unimpaired by any evidence brought against them.

Judge Grier evidently so regarded the matter when, in his decision, he said: "Corliss has invented an improved method of opening and shutting circular slides, or sliding valves; has shown another combination of devices for tripping the valve, and how his falling weight, used to close the valve, may be cushioned without jar on an air cushion. One has perfected one combination of devices for tripping a puppet-valve; the other a different one for a different valve. One has discovered and perfected a water reservoir to prevent the destruction of his valves when falling into place; the other has converted his falling weight into a piston working into a socket and cushioned on air so as to break the shock of its fall. They have each perfected a different machine by appropriate devices so as to operate beneficially, and I cannot perceive that the combination of elements in each is the same, and that their difference is merely colorable and not substantial."

If Judge Grier was right in this view,—and from the evidence we think he was right,—the litigation ought to have ended the controversy, and its revival after the death of both contestants can do no good except, perhaps, to insure that the honor of priority in the invention of a trip cut-off device for steam-engine valves shall be accorded to Sickels. The fact that Sickels's invention suggested a still better one to Corliss ought not to reflect any dishonor upon the latter. It is rare that the first practicable device for effecting any mechanical result is not ultimately superseded by something better, or at least equally good. That Corliss was a better business man than Sickels can hardly be counted against him, and for our part we are willing to believe that the wealth acquired by Mr. Corliss from his improvements was as honorably gained as any fortune similarly amassed in the history of patented improvements.

Both these men honored their country by their talents. Both have passed from the scene of human action. That one died rich, the other poor, matters nothing to either now. What benefit can the revival of this dispute render to any one? Let it and them rest in peace.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mechanical Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

The Machine Shop.

30850. Machine Molding With Special Reference to the Manufacture of Gears. Ill. S. Groves (Ir Age–April 11.) 3000 w.

31194. Fast Lathe Work. Ill. Isaac Chick (Am Mech–April 25.) 3000 w.

31243. Future Improvements in Foundry Work. Herbert M. Ramp, with Discussion (Ir Tr Rev–April 25.) 4000 w.

*31365. Boiler Making. C. E. Fourness (Loc Engng–May.) 900 w.

31417. New Tools for Turret Machine Work. Ill. (Am Mach–May 2.) 1000 w.

Steam Engineering.

30919. Initial Increase of Entropy, and Thermal Lag in Steam Machinery. Charles M. Jones (Am Mach–April 11.) 1500 w.

30976. Stationary Boiler Practice and Shop Heating. Notes of C. M. Higginson, with Discussion and Editorial. (Ry Rev–April 13.) 2200 w.

We supply copies of these articles. See introductory.

31014. The Hogan Vertical Water-Tube Boiler. Ill. (Ir Age-April 18.) 1500 w.

*31031. The Steam Engines (Persons in Charge) Bill (*Mech Wrld*-April 12.) 2400 w.

31093. The Woburn Explosion.—What the Inquest Discloses (Bos Jour of Com-April 20.) 3300 w.

*31112. Smoke: Its Production and Prevention. Vivian B. Lewes (*Gas Wrld*-April 13.) 4800 w.

*31121. The Governing of Steam Engines. G. L. Addenbrooke (*Elect'n*-April 12.) 1500 w.

31189. The Holly Gravity Return System for Utilizing Water of Condensation. Ill. (Elec Eng-April 24.) 1800 w.

31213. Causes of Explosions, Weight, Volume and Velocity of Steam, and Boiler Testing (Safety V-April 15.) 1800 w.

31216. The Making of Steam (Safety V-April 15.) 2000 w.

31230. The Woburn Explosion—Report of the State Inspector as to the Cause (Bos Jour Com-April 27.) 2800 w.

31231. Steam Pipes for High Pressures—Mild Steel Recommended by English Engineers (Bos Jour Com-April 27.) 1500 w.

31244. Hints on Boiler Inspection. Charles H. Garlick (Sta Eng-April.) 1200 w.

31247. Packing Rods. George West (Sta Eng-April.) 800 w.

*31280. The Conditions Necessary for Flame. W. H. Booth (*Elec Rev*-April 19.) 1000 w.

31469 Boiler Setting. Ill. George H. Barrus (Eng Rec-May 4.) 1800 w.

31470. The Ideal Cotton Mill Steam Plant. (Extract) George I. Rockwood (Eng Rec-May 4.) 1900 w.

31475. Hints on Boiler Inspection—How an Engineer Thinks a Boiler Should be Cared for (Bos Jour Com-May 4.) 900 w.

31501. Losses in the Steam Engine. William A. Bole (Am Gas Lgt Jour-May 6.) 4800 w.

*31535. The Care of Boilers. F. Riddell (Am Mill-May.) 1000 w.

31593. Some Historical Notes Relative to Governors and Their Use for Determining the Point of Cut-off in Steam Engines. Ill. W. F. Durfee (Am Mach-May 9.) 2000 w.

Miscellany.

*30833. The Growth of American Export Trade.—Words of Wisdom for Manufacturers. T. A. Eddy and Carl Schurz (Eng Mag-June.) 3000 w.

†30856. The Redheffer Perpetual Motion Machine. Ill. Henry Morton (Jour Fr Inst-April.) 1000 w.

30865. The Taylor Hydraulic Air Compressing System. Ill. (Can Eng-April.) 2300 w.

*30900. How the Moderns Move Heavy Masses Ill. (Stone-April.) 1300 w.

*30903. Steel vs. Iron Fire Box Stays. Editorial (*Eng*-April 5) 1400 w.

30918. Frederick E. Sickels and His Cut-off. W. F. Durfee (Am Mach-April 11.) 2500 w.

30920. Lubricators. Ill. (Inv Age-April.) 900 w.

*30941. Sand Blast Processes. Ill. John J. Holtzapffel (*Jour Soc of Arts*-April 5.) 8800 w.

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31019. Fly-Wheel Arms. Ill. Albert E. Guy (Am Mach-April 18.) 2000 w.

31020. Compressed Air for Small Engines. Frank Richards (Am Mach-April 18.) 2000 w.

31021. Air Compression—A Bit of History. W. H. Booth (Am Mach-April 18.) 1600 w.

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31050. Gas and Oil Engines and Their Prospects.—Discussion at the "Engineering Evening" of the Amer. Soc. of Mech. Eng. (Eng News-April 18.) 3500 w.

31171. The Relative Value of Different Fuels. E. P. Reichhelm (Mnfr & Builder-Dec.) 1200 w.

31172. The Potential Heat in Coal. W. E. Partridge (Mnfr & Builder-Dec.) 1500 w.

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31215. Energized by Inter-Atomic Ether.—The Keely Motor Ready for Work—So It Is Said (Safety V-April 15.) 1000 w.

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31418. Weight and Mass. Charles T. Porter (Am Mach-May 2.) 2500 w.

*31423. Some Experiments on the Efficiency of Air Propellers. Ill. Henry Goldmark (Am Eng & R R Jour-May.) 1800 w.

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31424. Coal Handling by Machinery. Ill. (Power-May.) 1200 w.

31473. Water Power.—At Lowell. (Extract). Samuel Webber (Bos Jour Com-May 4) 1300 w.

†31484. System in a Technical School Shop. W. H. Vandervoort (Tech-No. 9) 1800 w.

†31489. Tests of Three Babcock and Wilcox Boilers at the Champaign Electric Light and Power Station. R. A. Wood (Tech-No. 9.) 2500 w.

*31509. Apparatus for the Combustion of Small Coal. Ill. Felix Colomer (*Col Guard*-April 26.) 4000 w.

*31518. Rock Drilling Machinery. Editorial (*Min Jour*-April 27) 1400 w.

*31534. The Measurement of Power. F. Riddell (Am Mill-May.) 1000 w.

31581. Compressed Air: Its Utility and Advantages as Applied to Foundry Purposes. Howard A. Pedrick (Ir Age-May 9.) 3200 w.

31582. The Johnson Plant at Lorain. Ill. (Ir Age-May 9.) 5000 w.

31589. Force and Energy. Editorial (Sci Amer-May 11.) 900 w

31590. Purdue University, La Fayette, Indiana. Ill. (Sci Amer-May 11.) 1200 w.

31596. Compressed Air vs. Electricity. Frank Richards (Am Mach-May 9.) 1600 w.

†31613. How Pneumatic Tires Are Made. John F. Grierson (Ind Rub Wld-May 10.) 1300 w.

Serials.

13033. Practical Hints to Boilermakers and Templaters. Ill. (*Mech Wrld*-Began May 12, 1893—17 parts to date—30 cts. each).

16781. Rope Driving. J. J. Flather (Elec Wld-Began Oct. 26, 1893—15 parts to date—15 cts. each).

18044. Motive Power and Gearing. Ill. E. Tremlett Carter (*Elct'n*-Began Dec. 1, 1893—33 parts to date—30 cts. each).

19638. Blowing Engines and Machinery. Ill. Albrecht von Ihering (Eng Mech-Began Feb., 1894—13 parts to date—30 cts. each).

21141. High Speed Steam Engines. John Radinger (Eng Mech-Began April, 1894—14 parts to date—30 cts. each).

24338. The Gas Engine (Pro Age-Began Aug. 15, 1894—13 parts to date—15 cts. each).

24930. Some Notes for Enginemen and Firemen. W. H. Booth (*Elec*-Began Aug. 31, 1894—17 parts to date—30 cts. each).

27182. Notes on the Construction and Use of Pressure Gauges. C. R. L. Lemkes (*Mech Wrld*-Began Nov. 23, 1894—Ended April 26, 1895—5 parts—30 cts. each).

27633. Engine Governors and Governing Mechanisms. Ill. R. Gordon Blaine (*Mech Wrld*-Began Dec. 7, 1894—8 parts to date—30 cts. each).

29630. The New Nordenfelt Guns. Ill. (*Engng*-Began Feb. 15—Ended April 12—8 parts—30 cts. each).

29777. The Deterioration of Locomotive and Marine Boilers Due to Expansion and the Means of Lessening the Same. Herr Lentz (Am Eng & Rail Jour-Began March—Ended May—3 parts—30 cts. each).

29886. Defects in Steam Boilers. Ill. From Report by the Austrian Asso. of Eng. & Arch. (Ir Age-Began March 7—3 parts to date—15 cts. each).

30098. Inventions in the Wool Manufacture. S. N. D. North (Inv Age-Began March—Ended April—3 parts—15 cts. each).

30118. Force, Energy and Power. P. Lobben (Am Mach-Began March 14—2 parts to date—15 cts. each).

30216. Care and Maintenance of Machinery. "Quirk." (Tradesman-Began March 15—4 parts to date—15 cts. each).

30285. Engine Frame and Cylinder Tools. Herman Landro (Am Mach-Began March 21—2 parts to date—15 cts. each).

30456. The Cornell Dividing Engine. Ill. George F. Ballou (Am Mach-Began March 28—2 parts to date—15 cts. each).

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30810. Blast Pipes and Serve Tubes in Locomotives. Ill. (*Prac Eng*-Began March 29—Ended April 5—2 parts—30 cts. each).

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31380. The Birth and Commercial Development of the Gas Engine in America. James Schleicher (Pro Age-Began May 1—1 part to date—15 cts).

31413. Old Master Mechanics. Extracts from a Lecture by John Richards (Ind'y-Began May—1 part to date—30 cts).

31504. Modern Foundry Practice (*Engng*-Began April 26—1 part to date—30 cts).

We supply copies of these articles. See introductory.

MINING & METALLURGY

The Philosophy of Stamp-Milling.

IN the *Engineering and Mining Journal* Mr. T. A. Rickard discusses the theory and practice of the wet-crushing system of gold stamp-mills. The subject is by no means so simple as might appear at first glance, and the many points brought out by Mr. Rickard cannot be even mentioned in a necessarily brief notice. One matter, however, is worthy of more attention than it often receives, especially from inexperienced graduates of the technical schools and from the "process men." The author puts it in this way: "Milling is a matter of business. The closest application of technical science may occasionally be obtained at the expense of the best commercial results. Thus, you may save 85 per cent. of the value of an ore at a cost of 80 cents per ton. By the use of further skill and added apparatus [and allowing more time] you may extract 5 per cent. more, but the value of that additional saving may be less than the actual expense, so that, while you get $3.20 out of a $4.00 ore at a cost of 80 cents, you obtain $3.40 at a cost of over $1.10. Your additional 20 cents' worth of gold has cost more than 30 cents to obtain." Substituting 80 per cent. for the assumed 85 per cent. (an evident misprint), the figures come out right.

The old controversy between the advocates of the two extreme systems of gold milling—the California and the "Gilpin county" (Colorado) methods—is approached by the author with an evident desire to be impartial. In the former system the battery is designed primarily as a crushing machine, battery-amalgamation being incidental only; and hence a heavy stamp, low drop, low discharge, narrow mortar, and high speed are the rule. In the Gilpin county mills the stamp is light, the drop high, the discharge high, mortar wide, and the speed very slow, the idea being to use the battery as an amalgamating apparatus quite as much as a pulverizer, and hence to retain the pulp in the mortar longer than is necessary for passing the ordinary screen. Mr. Rickard gives the history of the evolution of the two types, and the reasons which brought about the divergence. He considers each especially adapted to the character of the ore treated in each instance, and shows that various modifications have been made both in California and Colorado, aimed to secure the best results from ores which do not call for the use of one or the other extreme type of battery.

As to the question of substituting a crushing-concentration-shipping-smelting system for the crushing-amalgamation and subsidiary concentration of difficult pyritous gold ores, Mr. Rickard, assuming certain figures as data, holds that the former method is the more profitable. In this opinion he will not be supported by all metallurgists; but the matter hinges upon the reliability of the assumed data.

Workingmen Mine-Inspectors in France.

SOCIALISTIC agitation in Europe, which for some years has tended to shape legislation in regard to labor, has in France taken form in a movement toward the inspection and control of mines, particularly collieries, by representatives of the working miners. In 1890 a law was enacted, wholly unique in character, providing for the appointment and pay of miners, "delegates" and prescribing their powers and functions. Lately a supplementary bill has been brought forward increasing the scope of the former act. M. P. Plichon discusses, in the *Revue Universelle des Mines*, the history and working of such legislation, and his essay is translated in the *Colliery Guardian*. M. Plichon remarks that the act of 1890 shows very clearly the aim in view in the "unequal struggle between the employer and the workman," and illustrates the evolution of the social theories which are every day becoming more pronounced in Europe. The object was to assure in a

large degree the safety of the men employed in mines, and under the law they have a right to choose some of their fellow-workmen or former companions, and to delegate them to visit twice a month the works in any given district. In case of death or severe injury from accident, or where the safety of the miners is endangered, the delegate may without delay visit the place where such accident has occured. The delegate enters his remarks in a register, and at once sends a copy to the prefect, who in turn reports back to the engineers of the mine. "Circuits" of inspection are established, not requiring more than six days for examination. Small workings, employing less than twenty-five men, may dispense with delegates. The pay (on basis of day's labor) is advanced by government, and by it recovered from the proprietors of the mines. M. Plichon does not believe that this law, which has not its equal in Belgium, Germany, or England, was necessitated by the frequency of mining accidents, which have been proportionately less in France than in other European countries. He also asserts that the law is of a nature rather to increase the difficulties in connection with the working of mines than to afford any greater security, subjecting operations to a kind of dual control; and that popular election and the influence of miners' unions tend to partiality in the performance of the delegate's duties. He considers that the government engineers and inspectors of mines —trained men—were sufficiently numerous and capable to conduct inspections, but that the new law, by dividing responsibility, would cause the engineers to relax their zeal. Finally, he shows that the appointment of the delegates has not been the means of preventing accidents. In view of the experience had under the law of 1890, M. Plichon argues strongly against any legislation looking toward the enlargement of the functions of the miners' delegates. As the proposition to establish a system of mine-inspection by representatives of the workmen is sometimes made in the United States and other countries, M. Plichon's account of the working of the French law is very pertinent. Evidently, wherever there is already an efficient system of State inspection and control, it is undesirable to complicate and thereby weaken it. But, if it can be shown that such control is lacking, a resort to the French system would be justified only in the event of failure to secure suitable official inspection, superadded to the intelligent self-interest of the mine managers, which, after all, is the most effective safeguard.

Coal Mining Under Sydney Harbor.

IT is proposed to carry into effect a project which aims at bringing from far below the lowest depths of Sydney harbor, New South Wales, the coal which geologists had predicted would be found there, and which has actually been tested by diamond-drill borings. *Transport*, in a recent issue, contains a very flattering account of the scheme now being floated on the London market, from which the following particulars are obtained. Important coal fields had been developed both north and south of Sydney,—at Newcastle and Bulli,—but up to the present the intervening area has been left practically untouched, although plainly shown on the government geological maps of 40 years ago. The unquestionable advantages which would follow the opening of coal mines in the very heart of the capital of the colony have led to the formation of a company, and induce our contemporary to take a most sanguine view of the outlook. Sydney is an important shipping port, where the lines of many steamship companies converge, and the coal of the bed in question is in demand for bunker use and export. The borings were made under the superintendence of the miners department of New South Wales, partly on account of geological interest and partly with the very practical ulterior view of raising revenue. The seam was found within 30 ft. of the depth predicted by the geologists, in a bore hole 2700 ft. deep. For 1500 ft. the borings passed through a compact sandstone, claimed to be impermeable to water. The seam itself is 10 ft. 3 in. thick, of which 6 ft. is clean coal free from band. The shafts to be sunk will be within 200 ft. of

deep water, so that the situation will be unique, the saving on cost of transportation from the nearest mines now working being about 75 cents to $1 a ton. The parent company has secured a surface site of small extent, but has concessions over 1400 acres below ground (and water), and it is expected that several other collieries will be started, for which there is said to be room.

There is nothing extraordinary in mining under water, as implied in the statements from which these points are derived, as this has been done on the Cornish coast and in the copper and iron mines of Michigan, at Silver Islet, Lake Superior, and elsewhere; but the opening of great collieries in a large shipping port, with a delivery from the shaft mouth directly into vessels alongside, is something which perhaps only the mines of Washington and British Columbia can rival.

It is also proposed to utilize the small coal, screened from the bunker coal, for a large electric installation, and also to make coke and establish local smelting works.

A Year's Work in the Transvaal.

A HIGHLY creditable annual report has recently been issued by the Witwatersrand chamber of mines, showing the work accomplished by that body during 1894 and also summarizing the operations of the Transvaal gold-mining districts during that year. This institution has made itself famous for its practical, well-directed investigation of technical questions, its carefully-prepared statistics, and the influence which it has had in developing the resources of the Transvaal; and, though merely a commercial organization supported by local public spirit, its work is a model for emulation by government bureaus established to further mining interests elsewhere, and shows what can and ought to be done wherever such work is attempted. The London *Mining Journal* (April 13) contains an abstract of the report, and calls attention to the successful influence which the chamber has brought to bear upon the Boer government in antagonizing the threatened official monopoly of the cyanid reduction process and the manufacture of cyanid. It has also aimed to secure a reduction of the onerous duties on the importation of explosives, which question is still pending. A committee has been studying the relative advantages of the direct treatment (by cyanid) of tailings from the battery plates and of concentration followed by cyaniding. The majority report of this committee states that, with such a cheap process, concentration cannot usually compete with direct treatment of tailings. The minority report is to the effect that under ordinary circumstances it is generally advantageous to concentrate tailings carrying more than 4 dwts. gold, while power tailings should be concentrated direct. A geological section cutting across the 'Rand has been made, and a complete geological survey of the gold fields is urged. The statistics accompanying the report show that in 1894 the total output of all the Transvaal districts was 2,265,853 troy ounces gold (which, we believe, means bullion, not fine gold), of which the Witwatersrand produced the great bulk, or 2,024,163 ounces, as follows: From mills (amalgamation), 1,305,408 ounces; concentrates, 84,579 ounces; tailings, 587,388 ounces; alluvial, 965 ounces; other sources, 45,821 ounces. The 'Rand mills, with 2273 stamps, crushed 2,827,365 tons of ore, working 334.04 days, the average duty per stamp being 3.72 tons in 24 hours, and the yield 9.23 dwts. (£1 13s. 3d.) per ton. The 'Rand is working over more tailings now than it produces, thus drawing upon the accumulated stock; while on the other hand the slimes, about 80,000 tons of which are saved monthly, are now to be rated as an asset, in view of the expected success of new methods of treating them. Altogether the growth of the Transvaal gold-mining industry has been as remarkable as rapid. The annual yield is over $40,000,000, and in 1895 the crushing capacity will be 50 per cent. greater than in 1894.

Impurities of Commercial Aluminum.

ALUMINUM, as prepared for industrial use, has iron and silicon as its principal impurities. Besides these, there are a

little carbon and some traces of nitrogen. In a communication to the *Comptes Rendus* (a translation of which, in abstract, appears in the *American Manufacturer* of March 8) M. Henri Moissan calls attention to the notable effect both carbon and nitrogen have upon the physical properties of aluminum, but says that it is to be hoped that electro-metallurgy will soon produce a metal purer and of more constant composition.

The iron alloyed in the product comes from the mineral from which the aluminum is derived and from the electrodes and crucibles used in its extraction. Although troublesome, it can be eliminated. Silicon also comes in part from the electrodes and crucibles, but mainly from the alumina employed; and the presence of this metalloid is more difficult to avert, although the amount has been easily diminished by a mere fusion of the metal under a coat of alkaline fluorid. In a footnote the author cites a case where the percentage of silicon was reduced from 0.81 to 0.37, the final product showing high elastic limit, breaking stress, and elongation. Nitrogen is easily taken up by molten aluminum, and affects it injuriously. Carbon has been found in a fixed state and in larger quantity (0.48 per cent.) than nitrogen. Tests made with samples prepared by adding crystallized aluminum carbid (made in the electric smelting furnace) to the molten metal, and comparing the product thus obtained with the same metal cast before the addition, showed that the presence of carbon greatly reduced the strength. The carbon contained in aluminum, according to this author, does not show a trace of graphite,—a rather unexpected result.

Grand Rapids Plaster Quarries.

IN the April number of *Stone* Mr. C. H. Redman gives a description of the gypsum mines and quarries at Grand Rapids and vicinity. There are two underground and four open workings, including a new quarry now being stripped. The open quarries near the town are in a bed of gypsum 12 ft. thick, very nearly level, and about 7 ft. below low-water mark of the Grand river, which cuts the bed in two. The combined area of the three working open quarries is between 5 and 6 acres. The rock is covered with a variable thickness of clay, gravel, and loam, the section in one quarry there showing alternate strata of limestone, shale, and impure plaster rock varying from a few inches to 3 ft. in thickness. In two other open quarries no rock is found above the 12-ft. gypsum bed, below which are "pencil rock," shale, sandstone, and 24 ft. of impure plaster rock. The underground mines were originally opened by vertical shafts, which are now used for ventilation, but are now worked by inclines of 1 ft. in 8 or 10 ft., on which tramways are laid leading to the mills, some 200 ft. distant at the foot of the bluffs. The combined area of the two underground workings is about 33 acres. The total area of this bed is unknown, but it is thought to extend over a large territory, as it has been pierced in many places. At one point a bed of plaster rock between 20 and 30 ft. thick has been struck 80 ft. below the surface. The mines are about 130 ft. deep. A bed of from 5 to 7 ft. of gypsum lying directly above the 12 ft. bed is left as a roof. Supports of oak 12 to 24 in. in diameter are used, besides which pillars of the plaster rock 20 ft. in diameter are left standing at distances not less than 60 ft., center to center, for additional security. Blasting is done with giant powder, about 2 lbs. bringing down 8 to 10 tons of rock. Hand-drills are used. The 12-ft. bed is a pure and solid mass of gypsum, reddish at top and bluish below. In the center it is translucent, compact, fine-grained, and homogeneous, and can be taken out in large blocks. For ornamental use it is treated by a secret chemical process, sawn, and polished. In manufacturing the quarried rock it is crushed by rock-breakers and then ground by millstones or by pulverizing mills, and is then ready for use as "land plaster" for fertilizing. For calcined plaster or stucco the pulverized mineral is put into large iron kettles from 8 to 10 ft. in diameter and 8 ft. deep, and heated for 35 to 40 hours to evaporate the water. The calcined plaster is then carried by screw conveyors to bins

where it is spread in thin layers to cool. The total output of the five mills is about 250,000 barrels per year.

Effects of Sulphur in Cast Iron.

IN the *Iron Trade Review* of March 28 Mr. Thos. D. West made the statement that, "with proper conditions in melting, as a general thing sulphur is raised twice as much as silicon is lowered in remelting iron." In the same periodical (April 11) Mr. West recurs to the matter, and explains that the remark must not be taken to cover the action of any radical mixture which the founder may make; and he gives the results of some experiments bearing upon the question. Mr. West takes issue with Mr. Keep's deduction that the founder has no need to fear sulphur, and that cast iron will not absorb sulphur to affect its quality in being remelted. Mr. West's experiments lead him to affirm that iron will readily absorb sulphur from the fuel when being remelted, his results showing an increase of from .030 to .105 with fuel containing below 1 per cent. sulphur, the iron charged averaging about 1.60 silicon. He considers that the least variation in sulphur percentage is more effective in changing degrees of contraction and chill in an iron than a greater percentage of silicon or any other element in such mixtures as are used for making castings in general founding. "One point increase in sulphur can neutralize the effect of four to twelve points in silicon." Although sulphur may increase tensile strength, it greatly decreases resistance to deflection or elasticity, and hence excessive sulphur is to be feared, especially in light or medium machinery. One redeeming consideration about the action of sulphur is noted by Mr. West,—that, while iron has an affinity for sulphur while absorbing heat, it does not take kindly to retaining it when radiating its heat; and, if given a chance in a fluid state, sulphur will partly escape. The hotter iron is remelted and fluxed, also the longer it stands in a fluid state, the less sulphur will it contain. The top of a pig generally contains more sulphur than the bottom, according to Mr. West, owing to the sulphur being caught by the top crust in rising to escape.

Progress of the Cyanid Process.

ONE-QUARTER of the world's present output of gold, it is claimed, is obtained by the potassium cyanid leaching process. In South Africa this method of treatment has made great strides. In the United States its advance has been much slower heretofore, and, while a vast amount of experimenting has been done, it is only comparatively recently that the process has taken its place as a practical, working method on the large scale; and even yet the cyanid mills in America are not very numerous. More has been done in Colorado than elsewhere, though there are scattered cyanid plants in the other western gold-mining States. In Colorado there are several cyanid works that have been in operation for various periods of time. Now, according to the Denver daily papers of recent date, several new and large ones are being built. The decadence of silver mining has turned the attention of miners and metallurgists more to gold than ever. In that State the practice, before the introduction of cyanid treatment, has been either to amalgamate the free ores and concentrate the sulphids and ship them to the valley-smelters for reduction, or to ship the gold ore in mass to the smelters, or to concentrate (without amalgamation) and ship the gold-bearing sulphids. In either case the ore, to cover costs of local treatment, freight, and smelting charges, had to run rather high in average tenor. Hence low-grade gold ores were neglected by prospectors, or, when met in working mines, were passed by and left as a possible reserve for utilization when metallurgical advance should render that profitable. There are immense quantities of low-grade ore in Colorado and in all the gold-mining States which have not been hitherto available, but which have become so by the advent of a process costing only from $2 to $4 per ton, with fair extraction percentage. The formation of a company to build a 300-ton plant at Leadville, to treat the ores from the gold belt of that district (which is popularly known merely as a

great silver-mining camp), is one of the signs of the times, and it is significant that the smelting-men have taken hold in earnest. This company, acting with some of the McArthur-Forrest people, has practically secured control of the patents on the cyanid process for the whole United States.

In this connection it may be noted that the appeal of the McArthur-Forrest Company against the adverse decision of the British royal high court of justice, made some months ago on the ground of former publication and anticipation, has resulted favorably to the appellants in effect, although the appeal was dismissed with costs. This peculiar situation results from the unfortunately broad claim that cyanid would dissolve gold. As to this the court said: "If the first claim had been disclaimed or omitted, they would not have been faced with the difficulty they were; but, as it was in the specification, they were unable to read it as the plaintiffs desired to do, and for that reason, and for that reason alone, they must with reluctance give judgment for the defendants." As to the narrower claims the court pointed out that the invention consisted not merely in discovering that cyanid of potassium could be used to extract gold from its ore, but in showing the public the best practical method of doing it, by leaving baser metals behind, which had never occured to anyone before. As to its having been anticipated by the prior specification, it would be remembered that from not one of them had any commercial result ever been attained. The claim of the United States patent, as it is well known, is narrower and more specific than this broad English claim, and is carefully limited so as to cover only a specified strength of cyanogen, which latter, it may be added, is the only kind of solution which has been found effective in this country. In this connection the following from the decision is quoted: "The selective action claimed by the plaintiffs, and the application of a very dilute solution containing an extremely small quantity of cyanid of potassium to ore containing gold, had, in the opinion of their lordships, been proved."

THE ENGINEER reprints from a Chicago newspaper an account of the borax industry in California and Nevada, from which it appears that borax crystals are no longer dug in quantity from the borax marshes, because a more abundant supply is found in the borate of lime impregnating rock, which is obtained by regular mining. The borax region is destitute of water and fuel, entailing great difficulties and hardships to the men. The crude brown "ore" is hauled long distances across the desert in broad-tired wagons to the railroad, and thence taken to the refineries, one of the largest of which is on San Francisco bay, several hundred miles distant.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mining and Metallurgy in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

*30840. The Advances in Modern Iron Smelting. Ill. John Birkinbine (Eng Mag-June.) 3000 w.

30851. Melting Gray Iron with Natural Gas. Ill. Burt H. Whiteley (Ir Age-April 11.) 700w.

30907. The Hardening of Steel. Abstract from M. C. Charpy (Eng & Min Jour-April 13.) 800 w.

30908. Determination of Tungsten. F. Cremer (Eng & Min. Jour-April 13.) 600 w.

30980. Effects of Sulphur in Cast Iron. Thomas D. West (Ir Tr Rev-April 11.) 1200 w.

31012. The Fatigue of Metals. P. Kreuzpointer (Ir Age-April 18.) 2200 w.

31015. Utilization of Blast Furnace Cinder. S. Norton (Ir Age-April 18.) 800 w.

†31073. The Wet Assay for Copper. R. S. Dulin (Jour Am Chem Soc-May.) 1800 w.

†31075. The Determination of Sulphur in Pyrites.—A Reply to Dr. Lunge. Thomas S. Gladding (Jour Am Chem Soc-May.) 1500 w.

†31076. The Zimmermann-Reinhardt Method for the Determination of Iron in Iron Ores. C. T. Mixer and H. W. DuBois (Jour Am Chem Soc-May.) 1600 w.

31089. The Decision of the English Court of Appeals in the Cyanide Case (Eng & Min Jour-April 20.) 1100 w.

We supply copies of these articles. See introductory.

31091. The Iron Industry of France—1893 (Eng & Min Jour-April 20.) 1500 w.

31092. Copper Assaying at Lake Superior. G. L. Heath (Eng & Min Jour-April 20.) 1500 w.

31233. Treatment of Ores in the Cooney Mining District, New Mexico. Carl Anderson (Eng & Min Jour-April 27.) 1000 w.

†31236. The Iron Situation in the United States. A. I. Findley (Bank Mag-April.) 5500 w.

31242. Xpansion of Cast Iron in Solidifying. E. D. Estrada. Read before the Eng. Soc. of W. Penn. (Ir Tr Rev-April 25.) 1300 w.

*31287. Ten Years Progress in the Metallurgy of Copper. Henry W. Edwards (*Min Jour*-April 20.) 2600 w.

*31334. The Cyanide Patent Case. Editorial (*Eng*-April 19.) 1500 w.

31392. Silver Alloys. G. J. Fowler and P. J. Hartog, with Discussion (Sci Am Sup-May 4.) 2300 w.

*31404. The Development of the Russian Metallurgical Industry (*Bd of Tr Jour*-April.) 700 w.

†31440. On a New Method for the Separation of Copper and Cadmium in Qualitative Analysis. Allerton S. Cushman (Am Chem Jour-May.) 1500 w.

31459. Is the Use of Cyanide of Potassium for Gold Extraction Common Property? Letter from E. Andreoli (Eng & Min Jour-May 4.) 2500 w.

31460. Two Interesting Cases of Abnormal Condition in Pig Iron. (Abstract.) T. W. Hogg (Eng & Min Jour-May 4.) 1200 w.

*31506. Coal and Coke in Upper Silesia, with Some Observations on the Rational Utilization of Coke Oven and Blast Furnace Gases. Alexandre Gouvy (*Col Guard*-April 26.) 4500 w.

31532. Milling Arizona Gold Ores with a "Colorado" Stamp Mill. Willard S. Morse (Min Ind & Tr-May 2.) 1200 w.

31533. A New Departure for Steel. Editorial (Age of St-May 4) 700 w.

31547. Remarkable Decline in Iron and Steel Prices. From the London Economist (Ry Age-May 3.) 1000 w.

*31564. Some Historical Notes on the Hot Blast. Ill. A. Humboldt Sexton (*Ir & Coal Tr Rev*-April 26.) 3800 w.

31594. Accurate Milling. Ill. Horace L. Arnold (Am Mach-May 9) 1800 w.

Mining.

*30839. Wooden Stave Pipe for Conveying Water. A Novel Expedient of the Mining Regions. Arthur Lakes. (Eng Mag-June.) 3000 w.

30870. The Largest Piece of Gold Yet Found Was Worth Nearly $150,000.—Other Nuggets. Argus (Min & Sci Pr-April 6.) 500 w.

*30896. The Grand Rapids Plaster Quarries. C. H. Redman (Stone-April) 1400 w.

30906. The Cooney Mining District, Socorro Co., New Mexico. Ill. Carl Andersen (Eng & Min Jour-April 13) 1000 w.

30978. Borax Mining.—From Chicago Record (Eng-April 13.) 700 w.

*30982. Aiseau-Presle Colliery, Farciennes, Charleroi (*Col Guard*-April 5) 5400 w.

*30983. Working-Men Mines Inspectors in France. P. Plinchon (*Col Guard*-April 5.) 2000 w.

*30984. The Fire and Gas Explosion at the Blanzy Colliery, France (*Col Guard*-April 5.) 1600 w.

*31008. Historical Notes on Early Plans for Coal Washing. F. J. Rowan (*Aust Min Stand*-March 2.) 1200 w.

*31023 Diamond Washing and Concentration (*Min Jour*-April 6.) 1800 w.

*31025. The Mineral Wealth of Nova Scotia. Editorial (*Min Jour*-April 6.)1300 w.

31079. Description of the Gold Belt of California. Ill. W. Turner (Min & Sci Pr-April 13.) 3800 w.

*31135. A Year's Work in the Transvaal (*Min Jour*-April 13.) 3000 w.

31197. Red Rock, Goler and Summit Mining Districts in Kern County. Ill. (Min & Sci Pr-April 20.) 900 w.

31234. Auriferous Conglomerate in California. Harold W. Fairbanks (Eng & Min Jour-April 27.) 1500 w.

†31237. Gold Fields of Africa. Hamilton Smith, in the London Times (Bank Mag-April.) 3800 w.

*31249. Randt Mining in the Past Quarter. Editorial (*Min Wrld*-April 20) 1200 w.

*31285. Gold Mining Progress in California. Editorial (*Min Jour*-April 20.) 2000 w.

*31291. Alaska.—Facts about the Yukon. Wilbur F. Cornell (Min Rev-April 26.) 1200 w.

*31327. The Courrieres Collieries, Pas-de-Calais, France (*Col Guard*-April 19) 1800 w.

*31329 Merionethshire Slate Mines (*Col Guard*-April 19.) 3500 w.

31353 An Interesting Placer Plant. Ill. (Min Ind & Tr-April 25.) 1500 w.

31395. The Early days of Petroleum From the New York Tribune (Ir Age-May 2.) 2700 w.

*31399. Coal Dust as an Explosive Agent. Donald M. D. Stuart (*Jour Gas Lgt*-April 23.) 1000 w.

31454. A New Use for the Air Caisson. Ill. F. E. Nettleton (Min & Sci Pr-April 27.) 500 w.

31457. Oil in the South (Mfrs Rec-May 3.) 1000 w.

31458. The Copper Production of the United States in 1894 (Eng & Min Jour-May 4.) 700 w.

31461. The Ammon Mines, Fergus County, Mont. H. C. Freeman (Eng & Min Jour-May 4) 900 w.

*31508 The Inundation of Mines (*Col Guard*-April 26.) 3500 w.

*31517. Southern Cross, Western Australia. Brenton Symons (*Min Jour*-April 27.) 2500 w.

*31519. The Osceola Mine. Description of a Noted Copper Mine. Ill. (Col Eng-May.) 2800 w.

*31522. Interesting Mining History.—The First Exhaust Fan Used at an American Coal Mine. Thomas H. Walton (Col Eng-May.) 1800 w.

*31523. The Sand Coulee Mines. J. L. Parker (Col Eng-May.) 2000 w.

31537. The Corundum Deposits of Georgia. William M. Brewer (Tradesman-May 1.) 3800 w.

31552. Gold Mining in British Columbia. From Report of Dr. George Dawson (Can Min Rev-April.) 4000 w.

31553. Characteristics of Explosives. William Glenn (Can Min Rev-April.) 3200 w.

31554. Gold Mining in the County of Beauce, Que. W. Prideaux (Can Min Rev-April.) 1500 w.

31555. Explosion by Lightning at a Nova Scotia Colliery. From a paper by T. Farmsworth (Can Min Rev-April.) 2000 w.

31556. Determining the Value of Gold Ores in the Field. R. W. Leonard (Can Min Rev-April.) 700 w.

31557 A Recent Trip to the Rainy River Gold Fields. F. Hille (Can Min Rev-April.) 2300 w.

Miscellany

30905. The Superficial Alteration of Ore Deposits. Abstract with Editorial. R. A. F. Penrose, Jr. (Eng & Min Jour-April 13.) 3500 w.

31090. New Apex and Tunnel Decisions. Francis T. Freeland (Eng & Min Jour-April 20.) 2000 w.

*31129. The Mining and Metallurgical Industries of Finland (*Ir & Steel Tr Jour*-April 13.) 1100 w.

*31406. Mining and Metallurgical Industries of Spain (*Bd of Tr Jour*-April.) 700 w.

31551. The Mineral Resources of Cape Breton. Editorial (Can Min Rev-April.) 1200 w.

Serials

20413. Mining Methods. Ill. (Col Eng-Began March, 1894—15 parts to date—30 cts. each).

20414. Geology of Coal. Ill. (Col Eng-Began March, 1894—15 parts to date—30 cts. each).

20415 Mining Machinery. Ill. (Col Eng-Began March, 1894—15 parts to date—30 cts. each).

20416. Chemistry of Mining. Ill (Col Eng-Began March, 1894—15 parts to date—30 cts. each).

22586. The Mineral Hydrocarbons (Min & Sci Pr-Began June 2, 1894—27 parts to date—15 cts. each).

27329. Coal Mining Economy Up to Date. Ill. (*Ir & Coal Tr Rev*-Began Nov. 23, 1894—13 parts to date—30 cts. each).

28786. The Mineral Wealth of Siberia (*Min Jour*-Began Jan. 19—Ended April 13—11 parts—30 cts. each).

29468. The Cyanide Process.—Its Practical Application and Economical Results. A. Scheidel (*Min Jour*-Began Feb. 9—11 parts to date—30 cts. each).

29599. Mining in Spain. (Asturias.) (*Min Jour*-Began Feb. 16—3 parts to date—30 cts. each).

29939. Pocket Hunting in California. W. H. Storms (Min & Sci Pr-Began March 2—3 parts to date—15 cts. each).

30009. Down in a Belgian Coal Mine. B. Lippens (Can Eng-Began March—Ended April—2 parts—15 cts. each).

30047. Prospecting.—Where and How to Find Gold and Silver Veins and Deposits. Ill. Arthur Lakes (Col Eng-Began March—3 parts to date—30 cts. each).

30049. Mine Surveying.—Latest American Ideas and Most Approved Practice. Ill. Edward B. Durham (Col Eng-Began March—3 parts to date—30 cts. each).

30274. Modern Coke Making. William Bowron (Tradesman-Began March 15—3 parts to date—15 cts. each).

30459. Modern Furnaces vs. Cupola Practice. Thomas D. West (Am Mach-Began March 28—2 parts to date—15 cts. each).

30461. The History of Iron. Ill. From Dr. Ludwig Beck (Ir Age-Began March 28—4 parts to date—15 cts. each).

30484. Characteristic Features of California Gold-Quartz Veins. Waldemar Lindgren (Min & Sci Pr-Began March 23—Ended April 20—3 parts—15cts. each)

30791. Gold Mining in Wales (*Min Jour*-Began March 30—Ended April 13—3 parts—30 cts. each).

30815. Furnaces for Roasting Gold-Bearing Ores. Ill C. G. Warnford Lock (*Ir & Coal Tr Rev*-Began March 29—Ended April 5—2 parts—30 cts. each).

30912. The Glasgow Iron and Steel Company's Works, Wishall. Ill. (*Engng*-Began April 5—2 parts to date—30 cts. each).

30962. Some Suggested Economies and Improvements in the Manufacture of Bar, Hoop and Sheet Iron; Having Special Reference to the Fuels Used and to the Furnaces Employed. Ernest W. Harvey (*Ir & Coal Tr Rev*-Began April 5—Ended April 26—4 parts—30 cts. each).

31107. The Luxemburg Iron Industry. J. Walter Pearse (*Col Guard*-Began April 11—Ended April 26—3 parts—30 cts. each).

31148. Bath Stone. Ill. (*Builder*-Began April 13—Ended April 20—2 parts—30 cts. each).

31330. Colliery Surface Works. Ill. Edward Brownfield Wain (*Col Guard*-Began April 19—2 parts to date—30 cts. each).

31511. The Tin-Plate Industry in the United States (*Eng*-Began April 26—1 part to date—30 cts).

MUNICIPAL ENGINEERING

A Plea for Contractors.

"MUCH mistrusted class," Mr. Charles A. Ewing, in *Paving and Municipal Engineering* for May, styles contractors. Moreover, he charges that this is the fault of the engineering profession itself. He argues for an extension of engineering ethics to contractors, which he styles the "other half" of the profession, and alleges that the evil can be easily remedied "by drawing up reasonable specifications," and simpler forms of contracts, "less autocratic, less dictatorial, less theoretical, less unnatural, less unreasonable. It is these alleged faults to which the mistrust of contractors is attributed.

"As to our first proposition, every engineer knows—in fact, the public at large knows—that a contractor will not do anything that he is not made to do; that he takes no special pride in his work; that he does nothing unforeseen or unspecified without extra charge; that the construction is carried on largely as a warfare; that in the preparation of specifications for any work the engineer lies awake at night wondering if he has left 'anything out,' and every day he is in dread of having his assistants or inspectors report at the office a case of failure to comply with specifications as regards material or workmanship, placing him under the painful necessity of becoming judge, jury, and executioner in dealing with the refractory contractor. Every engineer knows the great effort he makes to secure good bonds and to make a contractor thoroughly responsible. He knows that there is a sigh of relief when the work is done, although it is only approximately as well done as his specifications called for; in short, every one knows, including the contractor himself, that it is believed that he will beat you, if he can."

Specifications are too wordy, too much detailed, too elaborate; in short, they "are generally more faulty than the structure itself, and generally so full of provisos, arbitrary powers delegated to one party, and unnatural responsibilities laid on the other party, so full of bonds, acknowledgments, etc., that the contractor, thus given the suspicion and bad name in the start, generally deserves it in the end. Specifications are seldom read by the contractor until he commences work on the contract. This shows how little attention he pays to what has been carefully prepared. The first thing that strikes the eye in looking at the specifications is some glaring headline in red ink, telling him that 'prices must be written in words as well as in figures,' implying that he does not know how to write, and that his 2's may look like 4's, and his 3's may look like 8's. Or it may be that 'contractors are requested to notice any changes and insertions that may have been made in the specifications before depositing their bids,' thus telling the contractor plainly that the engineer has changed his mind or made some mistake. Or it may be in a redder red ink that 'bidders must accompany bids with a bond of so much,' etc., giving him to understand that his business career of a lifetime, his well-known work, his individual character, are as nothing compared to two men who are willing to sign their names for so much money. Then he turns the page, after some statements as to when the bids will be received, and finds 'Bonds A' and 'Bonds B,' with several blank notary acknowledgments as to his bondsmen being resident freeholders, and that he is held to commence the work, and that his bid cannot be withdrawn, although the 'right to reject any or all bids' is reserved by the other party. Then comes an approximate estimate of quantities, followed by a 'form of proposal,' and all before he has reached the specifications, which should precede the form of proposal, in order to enable him to know how to propose." Objectionable clauses and stereotyped phrases in specifications are the following: "The right to alter and to increase or decrease quantities"; "under

the direction of, and to the satisfaction of, the engineer"; "the contractor will be held responsible for all damages"; "no extra work will be paid for, unless ordered in writing"; "incompetent workmen must be dismissed at the request of the engineer or inspector."

The requirement recently inserted in specifications for municipal contracts in Cincinnati and other municipalities that persons employed shall have been residents of the city for a special time is severely, but justly, criticised, and held to be no more reasonable or justifiable than that the contractors also shall have been residents for a specified time. "Letting to the lowest bidder is wrong . . . . The right to reject any or all bids is an injustice. . . . . Work should be let to the lowest responsible bidder. . . . . Engineers should give advice as to best time, place, and methods of doing the work, as if they had the interest of a partner in the success of the work."

More About Calcium Carbid.

MESSRS. F. P. VENABLE and Thomas Clarke, of the University of North Carolina, have been experimenting with this substance in order to determine its reactions with various other substances. Some of the results obtained have been verified by Mr. W. R. Kenan. These results are contributed to *American Gas Light Journal* (April 15) by the first-named investigators. In view of the anticipations that have been raised that calcium carbid would enter into commerce as a source of the illuminant acetylene formed by the reaction of water on the carbid, the information given is timely and interesting.

"The calcium carbid used was prepared by the Wilson Aluminum Company. In this preparation lime is mixed with some form of carbon, as coal tar; the mass is then heated, with stirring until a thorough mixture is obtained. The proportions are so arranged that the mass becomes dry and hard on cooling. This mass, in lumps, is then placed in the electric furnace. In a very short time after the turning on of the current the process is complete. The molten mass can be run out of the crucible, or it may be removed after cooling. On examination it is easy to see that there is more or less of carbon unchanged, or rather converted into the graphic variety by the intense heat. Along with this are to be seen crystalline masses, lustrous and dark brownish black in color. These are quite hard, and break with a crystalline fracture. Several efforts at effecting a separation from the graphitic carbon were unsuccessful. The luster is slowly lost on exposure to air, more rapidly if the air be filled with moisture. The whole will finally crumble down into a gray powder with particles of black graphite interspersed through it. The carbid can be kept for a year or two, if placed in a tightly-stoppered bottle, and is quite easily preserved, if a little coal-oil is placed in the vessel containing it. If the gas as evolved (by the reaction of water upon it) is passed through a set of absorption flasks containing ammoniacal copper solution, it will be entirely absorbed,—not a bubble passing through, out of 1 or 2 liters of the gas. Thus it seems to be pure acetylene. The amount of gas yielded by any one sample will be affected to some extent by the amount of graphitic carbon present. Hence different lots will vary somewhat. The average is about 200 c. c. to the gram of carbid."

The gas so obtained burns with a fuliginous flame, but, if diluted with from six to ten parts of air, it generates a white flame of great illuminating power. Some caution is necessary to prevent accident with this gas. Like all highly-combustible gases, it forms an explosive mixture with air, and, if too large a proportion of air be mingled with it, a very violent explosion can be obtained by igniting it.

Dry hydrogen in the cold has no action upon calcium carbid. A reaction takes place when the hydrogen is ignited, the non-luminous hydrogen flame then becoming luminous. A tarry matter results. Dry air and oxygen also generate a luminous flame when passed over the hot carbid, with a similar production of tarry matter. Hot hydrochloric acid causes the carbid to swell and turn a dirty gray; in the cold it gives no reaction. The reaction with

chlorine and bromine is curious. Neither of these react when cold. Chlorine, when passed over heated lumps of the material, causes them to glow brightly, to swell, and to fuse together. In this experiment some of the carbid sublimates. The sublimate has a yellowish-white color. When subjected to similar treatment with bromine, the carbid turns red and glows, the lumps fuse together, bubbles indicate the escape of some sort of gas, and calcium bromid is formed. Strong sulphuric acid, when heated with the carbid, produced a gas that burned with a luminous flame; but, when potassium bichromate was presented to the carbid, no acetylene was generated. The action of alkalies also produces a gas supposed to be acetylene.

Park or Grove.

MR. F. A. WAUGH, in *Garden and Forest* (April), says that "there are very few real parks in western towns, unless delightful bits of virgin scenery are to be accepted under that head. The pleasure-grounds where, with natural conditions more or less propitious, an intelligent art has wrought any satisfying or pleasing effect are exceedingly rare. At the same time there are not wanting hundreds of attempts in this direction. Almost every prairie town of any consequence at all has its so-called park. Sometimes this park and the fair-grounds are combined. Whether this park be fair-grounds, race-track, or plain park, however, the location is usually upon some thoroughly flat, featureless, and treeless place, where the city council and the street commissioner can give their creative instincts full swing. This park is laid out in intricate and wonderful patterns. It contains race-tracks, baseball-grounds, camp-meeting-stands, carp-ponds, fountains, or fences, according to the whims of the street commissioner and the demands of the populace. It is profusely set with trees, cottonwoods having a large majority, and these are then left to struggle with a magnificent annual crop of sunflowers. This picture is not in the least overdrawn. Any one who has ever lived in the west knows it to be the sober truth. As a consequence of the construction and maintenance of this park, it is unfrequented and neglected. If the county fair is held on the grounds in the fall, the sunflowers are mowed, and for three days the park is crowded and useful.

"Now, it is a strange companion picture to this which one sees if he visits 'The Grove.' Near most towns will be found pieces of natural woodland, usually along some stream, to which the picnic parties always turn with natural impulse, which largely discredits their ill-conceived ideas of a park. Every town has its 'Wilson's grove' or 'Johnson's grove,' which is a place of this sort,—virgin woods and streams and rocks, unmarked by any attempt at art. This is the place to which the citizens all retreat when the appetite for fresh air and shade and out-door rest is to be satisfied. The name 'grove,' as applied to the picnicing rendezvous, in contradistinction to the park, is one of interest. These terms are commonly accepted and used with the utmost clearness of distinction, showing that in the popular mind the two articles are in no way related. Nevertheless, it would appear at once to the artist in landscape that the grove is by far the more satisfactory park. And, were the parks of western cities planned by landscape-artists, there is no doubt but that they would usually be located where unperverted instinct has found a satisfying grove, and seldom or never where false instruction has led citizens to make their so-called parks."

The unspoiled instinct for sylvan pleasures is demonstrated by the favor in which the grove is held, while the park, though showing the public spirit and liberality of the citizens, shows also their utter inappreciation of what a park could be made, if the expenditures that are freely bestowed upon the combined baseball-grounds and sunflower-patches were directed to improve the groves.

Pollution of Water-Supply.

A REPORT presented by a committee of the American Health Association at a meeting of that body in Montreal, and printed in the *Sanitary Record* (April 13), reviews a previous report that threw serious

doubts upon the sufficiency of any known artificial method of purifying town water-supply to which sewage has had access, and presents a different view based upon further study of filtration as now carried out by improved processes both in America and Europe. The prior report said: The bacteria of nitrification cannot be harnessed to the work of artificial filtration, and hence the results of such methods, although manifesting a satisfactory freedom from suspended matters, will in no instance compare with the organic purity which characterizes the spring and well-waters that are found in the laboratory of nature."

In the same document: "when the committee came to consider the specific matter of typhoid fever in a sewage-polluted water, it was equally positive that artificial filtration could not remove or destroy this infection. The committee recognized typhoid fever propagated by well-waters that had undergone a more efficient filtration through the soil than is effected by artificial filter-beds; and the story of the Lauzen epidemic seemed to indicate that a long subterranean course failed to remove the bacilli of typhoid fever."

The great work of the board of health of Massachusetts, the researches of Prof. Koch, the report of a royal commission on the water-supply of London, and other investigations seem to have completely upset the opinions expressed in the former report. The strongest argument in favor of filtration is summarized from the report of the local government board of London. "According to laboratory experiments, the bacillus of typhoid seldom retains its vitality in fecal matter for more than 15 days. The ordinary water bacteria, thriving in their natural habitat, deprive the intruding pathogenic bacilli of the conditions favorable to their development. They undoubtedly exert an influence in diminishing the vitality of the typhoid bacillus, either actually consuming it, or, as is more probable, giving rise to products that interfere with its growth. The diminished temperature of the water as compared with that of the human body is another unfavorable condition; and the sedimentation of suspended matters is such, particularly in storage reservoirs, as to carry down with them three-fourths, five-sixths, or even larger proportions of the bacteria present. Fourth, the vital action of filter-beds removes or destroys any pathogenic organisms. A new filter of perfectly purified sand has little effect, in producing either chemical or bacteriological purification, but, in course of use, a layer charged with living microbes is deposited on the surface and it is by these organisms, which constantly increase in number and also penetrate the sand to a slight distance, that nitrification and the arrest of other microbes are effected. Hence the longer a sand filter has been used, the more efficient it becomes, provided it does not become so dense on its surface as to prevent the satisfactory passage of the water. This filtration by the London Water Company removes 98 or 99 per cent. of the microbes contained in the river water. Again, so far as regards pathogenic bacteria, not only has no such organism been found in the river-water, but none was found in the gelatinous layer of living microbes from the surface of a Pasteur-Chamberland filter after the passage of a considerable volume of raw river-water. The risk of the propagation of typhoid fever by the filtered metropolitan water is, therefore, regarded as very small. Moreover, it must be remembered that small doses of the typhoid bacillus may probably be swallowed with impunity by a healthy person, the bacilli entering the system being destroyed by the secretions or living cells of the alimentary canal before they are able to establish themselves."

Notation for Plans of Water-Supply.

AT a meeting of the Engineers' Club of Philadelphia, March 16, Mr. W. H. Dechant described a system of graphically indicating sizes of pipes on plans, which seems to be a useful innovation. This was used with success in plans for the water-supply systems of Reading, Pa. By it the size of any pipe can be seen at any point. In the Reading plans the sizes of pipes ranged from 4" to 24". "Taking the size of pipes in inches, and assuming the in-

ches as representing feet, broken lines are drawn, the blocks or dashes of which are drawn to scale five times the diameter of the pipes, in length, by the diameter of the pipe, in width. For example: For a 24-in. pipe, dashes were made to scale 120 ft. long by 24 ft. wide. For a 10-in. pipe the scale was 50 ft. long by 10 ft. wide. The spaces between these dashes were made equal to the length of dashes, and in these spaces were marked in Roman numerals the size of pipe."

The advantages of this plan are: "(1) Looking on the whole map or plan, the various sizes of pipe are presented graphically, showing at once the location of the large and small pipes. (2) The marking of the size all along the length at close intervals is very important where the sizes frequently change, and enables the size to be seen at once, without any reference to color or a following of the line to find a size mark. (3) The pipe-lines thus made are also peculiar and distinctive, making them easy to follow among the other lines or plans. The plans were to a scale of 290 ft. to an inch; these were reduced by photo-lithography so as to make them nearly 1000 ft. to an inch; even at this scale the sizes of pipes can be read with the naked eye."

Steam Street Railways in Italy.

THE *Street Railway Review* for April notes the fact that Italy is in advance of the United States in the use and development of suburban and interurban street railways for carrying freights. These lines are operated principally by steam, and they carry all sorts of things into and out of the cities, and from point to point within the city limits. These roads in suburban districts have sidings branching into private property, thus establishing "direct communication with farms, fruit-gardens, dairies, milk, factories, ironworks, brickworks, lime-kilns, quarries, and mines."

At Vinovo the fæcal matter from the town is thus conveyed to surrounding lands, upon which it is used for fertilization. The freight traffic on these lines had a remarkable development. The advantages resulting are important. "The cars are loaded on the spot, and freights are delivered without rehandling." For example, bricks "are received at Turin from the large yards at Beinasco in the original crates in which they were stacked in the field." "Curves have a radius of 55 yards, as a rule, although there are some of 20 and 40 yards. On the sharper curves the gage is slightly eased, and, as the rigid wheel-base is only 5 ft. 3 in. from axle to axle, the cars and locomotives readily pass. Gradients are very steep in some localities, but in only one place has resort been had to a rack rail. Single track forms nearly the entire mileage, double track occurring only on trunk lines used by different branches. The turn-outs are 360 ft. in length, giving 200 ft. clear track. Stations for the sale of tickets are usually located at the more important stopping-places in houses adjoining the track.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Municipal Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Gas Supply.

*30891. The Improvement of Lighting Duty (*Jour Gas Lgt*–April 2.) 2000 w.

*30892. The Action of Heat Upon Ethylene. Vivian B. Lewes (*Jour Gas Lgt*–April 2.) 1800 w.

*30893. The Composition of the Extinctive Atmospheres Produced by Flames. Frank Clowes (*Jour Gas Lgt*–April 2.) 900 w.

*30894. Mr. John West on Economical Lighting (*Jour Gas Lgt*–April 2.) 4000 w.

30969. Some of the Properties of Calcium Carbide. F. P. Venable and Thomas Clarke (Am Gas Lgt Jour–April 15.) 1500 w.

*31033. Address of Alexander Yuill at the Informal Meeting of Scottish Gas Managers, with Discussion (*Jour Gas Lgt*–April 9.) 9500 w.

*31034. The Labor Saving Plant at the Saltley (Birmingham) Gas Works. Ill. Henry Hack (*Jour Gas Lgt*–April 9.) 4000 w.

*31332. On the Safe Storage and Conveyance of Compressed Gases. H. Joshua Phillips (*Eng*–April 19.) 1500 w.

*31352. Gas in Bottling Stores. Thomas Fletcher (*Gas Wrld*–April 20.) 1500 w.

†31566. The Carbides and Acetylene Commercially Considered. Ill. T. L. Wilson and J. J. Suckert (Jour Fr Inst–May.) 6500 w.

We supply copies of these articles. See introductory.

31592. Radiant Tissue for Incandescent Gas Lamps. Ill. F. De Mare (Sci Am Sup-May 11.) 500 w.

Sewerage.

*31414. Sewerage in Foreign Cities. C. W. Chancellor (Ind'y-May.)2000 w.

*31444. Some Special Sewer Construction. Ill. E. Hill (Paving-May.) 900 w.

31465. Sewage-Disposal System, Reading, Pa. Ill. (Eng-Rec-May 4.) 1200 w.

†31480. Sewerage in Foreign Cities. C. W. Chancellor (San-May.) 6000 w.

Streets and Pavements.

*30897. Stone in Street Construction. I. C. U. (Stone-April.) 700 w.

30949. Road Building. Extract from lecture of F. V. Greene (Eng Rec-April 13.) 2000 w.

31043. Standard Tests of Paving Brick. J. B. Johnson (Eng News-April 18.) 3200 w.

31044. Recent Paving Brick Tests (Eng News-April 18.) 700 w.

*31156. Pavements of Cleveland, Ohio, Compared with Those of Other Cities. James Ritchie, with Discussion (Jour Asso Eng Soc-March.) 6000 w.

Water Supply.

30879. The New Steel and Masonry Water Supply Conduit, Rochester, N. Y. Ill. (Eng News-April 11.) 7000 w.

30881. A Method for Determining the Supply from a Given Watershed. Ill. James L. Greenleaf (Eng News-April 11.) 1800 w.

31046. The New Water Works System of Ottawa, Ill. Ill. (Eng News-April 18.) 900 w.

31048. Available Yield from Proposed Drainage Area of the Jersey City Water Company-Letters from Contractor and C. C. Vermeule (Eng News-April 18.) 1800 w.

31138. Testing Cast Iron Water Conduits. Ill. R. A. Cairns (Eng Rec-April 20.) 2500 w.

31139. The Mueggel Lake Water Filters (Eng Rec-April 20.) 2300 w.

*31143. Report of Committee on Pollution of Water Supplies. Charles Smart (*San Rec*-April 13.) 5000 w.

31205. Water Supply of North-Eastern New Jersey and the New Jersey Bid. Editorial (Eng News-April 25) 4000 w.

31225. The Prevention of Ice at Intakes. Conclusions of Edward B. Guthrie (Eng Rec-April 27.) 1800 w.

*31340. The London Water Companies ; Their Rights and Dangers (*Jour Gas Lgt*-April 16.) 1600 w.

31428. Specifications for Stand Pipes.-Letters from Freeman C. Coffin and William R. Webster. Ill. (Eng News-May 2.) 2700 w.

†31479. Household Water Supply. J. C. Chase (San-May.) 3300 w.

†31495. A Problem in Hydrostatics and Its Ingenious Solution. Ill. C. H. Ott (Pro Eng Club of Phila-April.) 1200 w.

31610. Failure of the Angel's Masonry Dam, Calaveras County, Cal. Ill. (Eng News-May 9.) 1200 w.

31612. Failure of the Dam of the Bouzey Reservoir in France (Eng News-May 9.) 800 w.

Miscellany.

*30835. The Ideal City Engineering Bureau. Francis Collingwood (Eng Mag-June.) 3000 w.

*30836. Problems in Providing a Water-Supply. Ill. Rudolph Hering (Eng Mag-June.) 3000 w.

30874. Municipal Industrial Schools. John G. McMynn (Elec Engng-April.) 1000 w.

†30989. Glasgow—A Model Municipality. W. E. Garrett Fisher (*Fort Rev*-April.) 8000 w.

*31178. Municipal Government in England. Edward Porritt (Chau-May.) 4000 w.

*31179. Queer Customs of the City of London. J. C. Thornley (Chau-May.) 3300 w.

†31273. A Chapter of Municipal Folly—The Squandering of New York's Public Franchises. A. C. Bernheim (Cent Mag-May.) 2800 w.

31397. The Metropolitan Parks of Boston. Editorial (Gar & For-May 1.) 1500 w.

31403. Park vs. Grove. F. A. Waugh (Gar & For-April 17.) 800 w.

*31443. System of Records in a City Engineer's Office. William Steyh (Paving-May.) 2000 w.

*31445. The New Department of Public Works in San Francisco. C. E. Grunsky (Paving-May.) 900 w.

*31502. New Drainage Works in Paris. Ill. (*Engng*-April 26.) 3500 w.

Serials.

5358. Sewage Purification in America. Ill. (Eng News-Began July 14, 1892—45 parts to date—15 cts. each).

24751. The Gas Manager Abroad (*Gas Wrld*-Began Aug. 25, 1894—13 parts to date—30 cts. each).

28265. Frontinus on the Water Supply of Rome, A. D. 97. Clemens Herschel (Eng Rec-Began Jan. 5—Ended May 4—7 parts—15 cts. each).

30950. Economical Lighting of Buildings and Workshops. John West (*Prac Eng*-Began April 5—Ended April 12—2 parts—30 cts. each).

30948. The New Rochester Water Works. Ill. (Eng Rec-Began April 13—4 parts to date—15 cts. each).

31082. Water Supply and Pipe Distribution. F. C. Moore (Fire & Water-Began April 20—3 parts to date—15 cts. each).

31137. Raising Water by the Air Lift (Eng Rec-Began April 20—1 part to date— 15 cts).

31204. Stand-Pipe Accident and Failures—Appendix to Series of Articles Concluded June 7, 1894. William D. Pence (Eng News-Began April 25—Ended May 2—2 parts—15 cts. each).

RAILROADING

Hard Times and the Railroads.

A STAFF writer of *The Peterson Magazine* has compiled an array of facts from railway statistics which forms part of a paper under the above title. The article is spun out by brief biographical sketches of railroad men, which, however interesting in themselves, do not seem entirely consonant with the title. Only the statistical part of the article will be herein considered. This presents to the general reading public the extent to which the railroads of the country have felt the hard times, and it will be a good corrective to the too prevalent notion that the railroad interests are growing rich at the expense of all other industries. The figures given indicate that only by the rigid reduction of expenses through sweeping economies have the roads fortunate enough to keep out of the hands of receivers been able to make ends meet.

In the midst of the strain upon the carrying capacity of many lines caused by the World's Fair at Chicago, and after large expenditures to meet the unusual conditions, the business panic came like a cyclone. This was followed by the great strike at Chicago, which not only caused a decrease of earnings, but entailed an unexpected and unusual expense upon some of the most important railways. The failure of crops followed, with consequent diminution of freight traffic. As usual in times of business depression, the railways suffered out of proportion to other industries. More than this, they still suffer from the effects of the prolonged commercial stagnation, and will continue to suffer after other industries are restored to health.

Figures taken from the report of the Interstate Commerce Commission show "that the year ending June 30, 1894, witnessed a falling off of $840 per mile in the gross revenues of 570 roads, representing 149,559 miles of operated line. As there are about 179,000 miles of operated line in the whole country, the same proportion of decline would show a falling off in the gross income of all the roads, for that year, of over $150,000,000. The same report shows that there was a shrinkage of $3,999,169 in the dividends paid on these 570 roads as compared with the dividends paid the year before. And, finally, it is shown that, after the payment of expenses and dividends, there was a total deficit of $28,255,-121 in the accounts of these roads, which was tabulated in the column usually headed 'surplus.' The heaviest falling off in dividends occurred in the Southern States, east of the Mississippi river, and in the States along the Pacific coast."

As yet no official statistics are available to show the losses in 1894 due to the failure of crops and the strikes. The *Financial Chronicle* is, however, quoted to show the falling off in "the gross receipts of the leading railways . . . for the last six months of 1894," which paper estimates the decrease to be $20,000,000, as compared with "the last six months of 1893." For the whole year and for all the roads it is estimated that the total decrease in gross income will not fall short of the enormous sum of $163,000,000.

Of course such a decrease had to be met by corresponding economies, or all the railroads would have been financially ruined, like the weaker ones for which receivers have been appointed.

"The economies practised by the various railways have been an astonishment. The New England roads, with a decline of over $2,500,000 in gross income, actually reduced their expenses so greatly that their net income showed an increase of $2,200,-000. As to the whole 206 roads tabulated, it is found that they reduced their operating expenses by $82,648,591, or 10.88 per cent., so as to show a decrease in their net income of only $40,323 603. Taxes, interest on bonds, and operating expenses must be met before dividends are possible. All economies are, in the nature of things, confined to the category of running expenses.

How this can be done, and to what extent it can be carried, is indicated by Mr. Chauncey Depew, who is reported to have made the following statement to an interviewer in reply to the question, 'How is it possible for a railroad to continue paying its dividends in such times as these?' Among other things Mr. Depew said: 'The only way to meet such an emergency is to reduce expenses. When that is said, the question naturally arises: "If you can economize so vastly now, why are not your expenses in good times pure extravagances?"

"'A road that is in first-class condition can run a year or two without spending much for new buildings and equipments. That means that you can discharge from one-fourth to one-third of your entire force of employees, and so cut down the pay-roll. You must stop constructing new tracks, and you must reduce your repairs to a minimum. Unless you have kept your road in first-class condition, you cannot do this; but, if you have, you can practice those economies about two years. It would be very poor economy, unless you had enough faith in the general prosperity of the country to be sure that you could bring the road up again to its normal standard of excellence.

"'The Lake Shore Railroad, now one of the strongest in the country, in 1873 found itself in such a dilapidated condition of roadway, equipment, and stations through this process of neglecting repairs in order to pay dividends in hard times, that, after the return of good times, it was forced to suspend paying dividends in order to raise sufficient money to put the road in shape again. These are painful times for the manager of a railroad, because he wants to get something for his stockholders, if possible, and at the same time he does not want to see the road run down. Especially does it grieve him to see good men out of employment through no fault of their own. There is simply nothing for them to do.'"

Mr. Depew is further quoted as saying that, "if the stringency should last for 4 or 5 years, few roads would be able to pay any but very small dividends." He expressed the view, however, that such a concurrence of financial depression and crop failures as we have passed through in 1894 is unlikely to occur again in a long time. The effect of the hard times upon the workmen employed by the railways is reviewed in our department of Industrial Sociology in the present number. The hard times not only bore hard upon stockholders, directors, and managers, but also fell with crushing force upon the army of railway employees.

Railroads in Default.

IN another place in this department the effect of hard times upon American railroads is considered. In connection with that review an article in *The Banker's Magazine* for April, entitled "Railroads in Default on Their Mortgage Bonds," proves that the railroad interests bore up against the pressure in a most remarkable manner. A statement made in a London newspaper that "about one-third of the railroads in the United States are in default on their bonds" is shown to be a gross exaggeration of actual facts, and an impression, prevalent both in this country and abroad, "that a large proportion of the railroads of the United States have failed to pay interest on their bonds" is erroneous. A careful examination of the subject is asserted to have been made for *The Banker's Magazine*, and it is found that out of 679 railways only 106, or less than one-sixth the whole number, are in default, while out of $5,600,000,000 of outstanding bonds "the amount now in default is $976,000,000, or less than 17½ per cent. of the whole." The roads are grouped, and the amount in default is apportioned to the different groups in the following tabulated statement.

NUMBER OF RAILROADS AND AMOUNT OF BONDS IN DEFAULT.

	Number of Roads.	Amount of Bonds.
New England States	1	$15,000,000
Middle States	8	92,529,400
Middle Western and Western States	32	100,921,290
Southern States	39	129,385,175
Southwestern States	7	29,907,000
Pacific Railroads	17	579,765,000
Pacific States	5	28,515,000
Grand total	109	$976,022,865

"In such times of panic and depression as this country has passed through during the past two years there is an unfortunate

tendency to exaggerate evils, and to overstate figures purporting to represent the extent of the troubles, especially in those branches of business where there are no government figures, nor any other statistics kept up with a reasonable degree of accuracy. It may, therefore, be somewhat reassuring to investors to know that only about 18 per cent. of the United States railroad bonds are now failing to yield promptly their interest as it falls due; and even this overstates the case, for the interest on quite a number of bonds embraced in the table is paid a few months after it becomes due, and the default in each instance is only temporary. Considering the unexampled depression in business and the decline in railroad earnings which has attended the financial crisis of 1893-1895, and particularly the collapse in business since the termination of the Chicago Fair in November, 1893, the question may reasonably be asked why no more railroads have gone to default, and how the companies of moderate financial strength have been able to bridge over the chasm and meet their obligations."

Substantially the same reason is assigned in answer to the question as is given in the article in *The Peterson Magazine*. The railroads were in good condition when the financial storm broke upon the country, and they have since in great measure "been living on their own fat." The *Banker's Magazine*, however, takes a far deeper and more comprehensive view of the "causes which led up to the great railroad disasters of 1893-1894," and inquires whether they are "likely to be repeated."

The following causes are named. "(1) The over-building of railroads, almost entirely out of the proceeds of bonds, in localities where the business in dull times was inadequate to support them. (2) An unreasonable hostility towards railroad capitalists, in some of the western and southern States and also in congress, which led to the passage of laws reducing freight rates and otherwise hampering the companies. (3) The enormous falling off in traffic which followed the silver crisis of 1893, owing to the suspension of banks and the general demoralization of trade. (4) In the case of particular roads, bad management."

Passing some elucidation of the way in which these causes have combined to injure railway business, we notice another cause not included in the above category. "There has unquestionably been too close a connection in the past between stock-exchange speculation and the management of leading railroad properties, and this is largely objectionable. But to those whose memories of Wall street run back for thirty years or more it is possible to see that this speculative tendency of managers has been constantly diminishing, and, as one property after another has reached a dividend-paying basis, the stocks have been taken for investment and removed from the control of speculators. But this gradual process is not sufficient; there should be a more pronounced public sentiment against all railroad officers who are speculating in the stocks of their respective roads, as it is practically impossible for an executive officer to act with perfect integrity and due regard to the interests of all stockholders, if he is selling and buying and again selling 'short' the stock of his own company. The very notoriety given to the proceedings of McLeod and Reinhart showed that such action on the part of railroad officers was considered a rare thing; but the revelations in Reading and Atchison had a serious effect abroad, and did much damage in prejudicing investors against American railroad bonds in general. If the real facts could be ascertained, it might be found that the effect of those two developments alone had been sufficient to cause a return of our railroad securities, and a withholding from investment in others, that was equivalent altogether to a balance against us of $25,000,000 or upwards. This subject is closely allied to the matter of gold exports and to the financial history of the past year."

The question raised as to whether the causes of disaster above enumerated are likely to be repeated does not seem conclusively answered, and, probably, if most people had to answer it, they would ask for something easier. It is thought "that the lessons of the past will not be lost,"

and that "railroad financiering will be conducted more carefully hereafter."

Locomotives with More than Two Cranks.

IN this department (April) we reviewed an article by Mr. Geo. S. Morrison in the *Railroad Gazette* (Feb. 22), wherein the adequacy of hitherto existing methods of balancing was questioned, and the possibility of attaining an accurate balance at highest speeds in four-cylinder locomotives with four cranks, two on each side, each pair set on the quarter from those on the opposite side, was asserted. The argument seemed conclusive that only in this way, or in some other way analogous to it, can be reached a satisfactory locomotive balance for the high speeds now in vogue, and the prospective higher speeds likely to be attempted in the near future.

Mr. Morrison's argument, however, does not seem convincing to *The Railroad Gazette*, which (April 12), editorially criticising an English correspondent's proposition to place cranks 180 deg. apart, and use an auxiliary engine for starting the cranks off from the center, states that "no one has been able to show that the use of two cranks at right angles makes it impossible to prevent injury to the track." But this appears to us just what Mr. Morrison claimed to have been demonstrated by recent investigations. The tracks of railroads, according to this eminent engineer, have suffered under modern high-speed running, and the injury has been directly traced to want of balance in locomotives. And he proceeds to show that "the only method whereby a locomotive can be perfectly counterbalanced is one in which the center of gravity is kept constant under all conditions, both vertically and horizontally."

He further shows that, if the two cranks of a locomotive were placed at an angle of 180° from each other, it would yet be impossible to keep the center of gravity constant, and that only a partial counterbalance could be thus obtained. The 180° angle being, for well-understood practical reasons, out of the question, either for a two- or a three-crank locomotive, and the quarter position being essential, it seems to us that the four-crank system is the only way to a perfect counterbalance, as asserted by Mr. Morrison.

An apology is made for even discussing the English correspondent's scheme, and the perusal of the entire article almost compels the belief that it would not have been noticed except for the opportunity to make the above-stated proposition regarding the alleged inability "to show that the use of two cranks at right angles makes it impossible to prevent injury to the track." The editorial under consideration says further:

"Those who are watching locomotive development know that we shall soon have for trial some four-cylinder, four-crank compounds, not unlike those tried in France. The prime object of these designs will be to do away with the effect of the counterbalances upon the track. They will demand some serious consideration, and it will be well to look ahead a bit and see what advantages they will probably offer, for advantages they must have or they can never meet with the approval of those who repair locomotives, on account of the greater number of wearing parts. The argument that is offered by those who will bring this type forward is that a compound engine is necessary for economy; that a two-cylinder compound is too heavy in its reciprocating parts on one side; and that four-cylinder compounds, with but two cranks, cannot be balanced with safety to the track. This argument has some holes in it, and these will be found, and must be stopped with logic; and—what is more important—facts as to the real condition of the designs of existing compounds must be gathered. First, it must be learned whether the compound locomotive gives any advantage at high speeds, and for this we may wait for the tests that are to be made at Purdue University, on the shop test locomotive. If the compound is not a decided advantage, then the simple two-cylinder locomotive is the best, so far, for high speeds, when it is properly designed."

The writer of the above quotation subsequently expresses the belief that injury to tracks may be avoided by reducing the

weights of reciprocating parts,—such as pistons and cross-heads; and doubtless, were wrought-steel pistons substituted for cast-iron ones, and so on, these parts could be made considerably lighter. But, when the principles laid down by Mr. Morrison are carefully considered, we cannot understand how it can be concluded that this change in design would result in anything more than a partial mitigation of track-pounding, while the four-wheel system would be a complete cure.

Competition of Electric Railways.

THE competition of trolley lines with previously-established lines of railway has become a matter of serious consideration for the managers of the old lines. Many of these have experienced a marked reduction of income from loss of what is styled "local suburban traffic," and trolley lines running short distances at frequent intervals between stations have absorbed a kind of traffic which, as long as it could be retained, was obtained without any material increase in cost of running expenses. On the other hand, its loss has not materially decreased expenses. This kind of traffic has, therefore, been an important item in the general business of railways.

The subject is now attracting much attention in railroad circles, and the papers published in the interest of railways are discussing it freely. *The Railway Age* (April 5) speaks of this competition as not only already serious, but prospective. It is likely to increase. "Within a few short months scores of rapidly-constructed and cheaply-run electric roads have been put in operation alongside of steam roads, and by their low fares and frequent service have at once deprived the latter of a large share of the suburban travel which they have been engaged for years, and often at a heavy loss, in building up. With possession of streets and highways given them without charge, and with no expense for grading, bridging, signaling, station building, ticket selling, and numerous other items of cost, the street-railway companies have simply had to lay down their rails and put up their poles and proceed to carry passengers at half or a quarter the rates at which the great roads are able to furnish their more costly accommodations. Every large city in the country is already the scene of this fast-growing competition, but in none has it thus far become so surprising as at Philadelphia. Here the trolley lines are allowed to enter the heart of the city, occupying almost every alternate one of the narrow streets, along which they rush at high speed to and from most of the numerous suburban towns within a distance of from 10 to perhaps 20 miles. The steam roads have instantly felt the effects, in a falling off from 50 to 70 per cent., and at some points even more, of their suburban travel, and this too in the winter, when the greater comfort of the steam cars is most appreciated. In warm weather, when open cars are attractive, the trolley business will naturally increase, as we demonstrated last summer, when 'trolley parties' were the rage on the Philadelphia roads which had then begun to reach the suburbs, and sufficient cars could not be provided to meet the demand. Many hundreds of miles of electric lines have been added throughout the country in the last few months, and thousands of miles more are already projected."

While Philadelphia has been quoted as a conspicuous example of trolley competition, it is by no means single in this respect. The trolley lines running in and out of Boston and New York have had a similar, if not so notable, an effect upon the steam railways. In Brooklyn the elevated roads have found the trolley competition difficult to meet, and, had it not been for the strikes on the trolley lines and the numerous accidents for which the trolley roads of Brooklyn have become famous or infamous, the struggle of the elevated roads to retain their patronage would have been still harder.

The steam lines running in and out of Philadelphia have endeavored to retain as much as possible of this kind of traffic by sweeping reductions of fares and by running more local trains. It is stated that their reduction of fares averages 40 per cent. "In Connecticut the competition has become so troublesome and the danger of level grade crossings by electric roads is

so great that the railway companies are demanding that the legislature throw around the new roads some of the same restrictions that the old roads endure. The management of the New York, New Haven & Hartford railroad made a statement showing the loss in the last 3 months by electric competition at various stations, ranging from 40 to as high as 95 per cent. Between Naugatuck and Waterbury (5 miles), for example, the sale of tickets had fallen off 7000 a month. It was urged with evident reason that, if the highways of the State are to be turned over to the electric roads, they should be placed under the same conditions and laws that the steam roads live under."

It is suggested that the steam roads may meet this competition "by putting trolley cars on their own tracks to do the short-distance passenger service," and it is stated that several roads have resolved to try this expedient. Among the roads named that will do this are the Pennsylvania on its Burlington & Mount Holly branch (6 miles), the New York, New Haven & Hartford on its Nantasket Beach branch (7 miles), and the New York Central, it is lately reported, on its Buffalo & Niagara Falls branch (22 miles). The article concludes with the opinion that, with long electric roads coming to the front and the great increase in local trolley lines to be reasonably expected, "the points at which the steam roads will not feel in greater or less degree the presence of this new and aggressive competitor in the next few years are likely to be few and far between."

Chilled Car-Wheels.

AN abstract of a paper read before the last annual meeting of the Association of Manufacturers of Chilled Car-Wheels, by Mr. William W. Lobdell, is printed in *The Iron Trade Review* (April 11). Chilled car-wheels are therein stated to be "a distinctively American product," for, although they are to some extent manufactured in Austria and Sweden, millions of these wheels are now turned out of more than one hundred different American establishments, and the industry, involving millions of capital, employs thousands of skilled workmen. Mr. Lobdell thinks some of the particulars of this industry will be new even to many "actively engaged in railroad management."

"When certain kinds of gray cast iron are melted and poured against a metallic mold, that portion of the iron next to the mold becomes hard, white, crystaline, and brittle, while the interior portion remains gray and more or less tough and fibrous. This conversion of the iron that comes in contact with the metallic mold into the hard, white variety is called 'chilling,' and it is upon this principle that the manufacture of chilled car-wheels depends. This property of chilling, which certain irons possess, must have been known to iron-founders at an early day, for we have evidence of the fact that parts of ploughs, faces of forge-hammers, punches for punching holes in wagon-tires, rolls for rolling metal, and various other implements, were chilled long before the manufacture of car-wheels."

Chilled castings and chilled wheels were originally made from charcoal irons, and, as the property of "chilling" is not possessed in a high degree by either coke or anthracite irons, for best results charcoal irons are still indispensable. "The plates and hub of the wheel must be cast in a sand mold, the result being that they are soft enough to be bored or machined, while the tread is so hard that the finest-tempered file will not affect it. What, then, is this peculiar property of chilling? The supposition is that the chemical difference between the chilled portion of a wheel and the plates or hub is simply in the proportion of combined and free or graphitic carbon, that of the chilled part being high in combined carbon, the free or graphitic carbon having been changed to combined by the rapid cooling of the tread by reason of its being cast against a metallic mold technically called a chill."

"This rapid cooling of the tread of the wheel—the metallic mold in which it is cast being a good conductor of heat, whilst the sand mold against which the hub and plates are cast is a poor conductor—causes an undue strain upon the wheel, which must be relieved in some manner, or the

wheel would be unfit for service. With the adoption of the form of pattern such as is used to-day came the necessity for some mode of slow cooling and annealing. Probably the first method practised was to take the wheels from the molds in which they were cast as soon as the iron was set, and cover them up in hot sand or ashes, and allow them to remain several days, until nearly cold. Another was to lay them on the floor and build a fire around the tread, so as to bring the temperature of the tread up to that of the hub and plates, and then allow them to cool slowly. To a certain extent both of these methods accomplished the desired results, and were probably sufficient for the requirements of the times in which they were practised. The latest and probably the best plan is to place the wheels, as soon as they can be removed from the molds, in tight pits lined with fire-brick, or some other substance, that will stand the heat,—ten or more in each pit. The wheels are allowed to remain in the pits several days, and are not removed until all tendency to fracture from strain has been removed."

The chilled portion of the tread is harder than any steel that can be used in a tire with safety. Mileages of from 200,000 to 300,000 have been obtained from 30-in. and 33-in. chilled wheels. Excessive heat may neutralize the effect of the chills, and, when brakes are applied to an extent that causes the wheels to slip, their friction on the track may produce heat sufficient to cause "shelled-out" spots. "If the wheel is broken through these shelled-out spots," a violet discoloration distinctly indicates that they are caused by heating. Manufacturers have been blamed in such cases, when the fault was not theirs.

"If the specifications and physical tests formulated by expert mechanical engineers and adopted by some prominent railroads of the country - and which are now much more severe and exacting than those first formulated—can be taken as a maximum required to meet the conditions of the increase in speed and weight of equipment of the present time, then the limit of the strength of cast-iron wheels has not been reached, as they are successfully met by all reputable manufacturers; and, as long as charcoal irons can be produced approximating 35,000 to 40,000 lbs. tensile strength per sq. in., it is not likely that the limit of strength will be exhausted, until the speed and weight of equipment are increased beyond anything now contemplated."

The Return to Single Drive-Wheels.

IT is curious to note in the history of inventions the occasional reversion to abandoned types of construction. Many things have been laid on the shelf, not because they were defective in themselves, but because they were found incompatible with then-existing conditions and requirements. General progress along the line of mechanical construction often changes conditions so much that what has been laid aside again becomes useful. The system of coupled drive-wheels was adopted for locomotives to avoid injury to tracks resulting from too heavy a load on single wheels. Steel rails substituted for iron ones have greatly increased the resistant power of the track against the action of wheels, and there are now indications of a return to single driving-wheels. It is true, the single driving-wheels have never gone wholly out of use, but coupled wheels for a considerable period have been the rule, and many have supposed the day of single driving-wheels to be past. On the contrary, *The Railway World* says that "one of the most conspicuous features of the recent development of the English express engine has been the return, by many of the largest lines, to the old system of single driving-wheels. Those companies which have never entirely given them up have lately been building new types of single engines for the fastest express traffic, and at the present time the single engine is more in favor in this country than it has been for the last twenty years."

The causes assigned for the restoration of the single wheel to favor are increased speed, reduction in the number of stoppages, and the longer runs now made; and it is stated that in English practice the "single engine has always done the best main-line work, and it is now capable of doing, on all but a few exceptionally steep

lines, practically all that a coupled engine can do."

The writer of the article, Mr. W. B. Paley, thinks that in the United States railroad men cannot be expected to appreciate "the merits of single engines, as they have practically no experience with them; but it is certain that the long runs and high speeds of trains like the Empire State expresses of the New York Central Railroad must be extremely trying to coupled engines, whatever may be the size of their driving-wheels." The reason for the adoption of the four-coupled express engine in England "was not so much because it was liked, as because the weight of the trains required more adhesion than could, with iron rails, be advantageously placed upon a single pair of wheels. The conveyance of third-class passengers by all trains gave an immense impulse to traveling, and, had not this coincided pretty closely with the discovery of how to make steel rails cheaply and well, it is nearly certain that the single engine would now be a thing of the past. To Mr. Patrick Sterling, locomotive engineer of the Northern Railway, is due the credit of having first foreseen the advantages and possibilities of the new rails. His 8-ft. single engines, with leading bogie, were designed about 1869, and the unusual load of 15 tons on the driving-wheels proved well within the endurance of the steel rails with which the Great Northern main line was even then partly laid. Although the third-class movement did not begin till 3 years after these engines were designed,—and it practically doubled the weight of the trains at once,—they are still able to cope with the heaviest traffic upon what has always been the fastest line in the kingdom. Except that the weight on the drivers has been increased to 17 tons, both in the old and the new engines, the design remains practically the same as it was 26 years ago. A few details of these splendid engines may be acceptable."

Diameter of bogie wheels, 3 ft. 10 in.; diameter of driving-wheels, 8 ft.; diameter of trailing wheels, 4 ft. 6 in.; number of tubes (copper), 174; diameter of tubes, 1¾ in.; largest diameter of boiler, 4 ft. 2 in.; length of boiler, 11 ft. 5 in.; diameter of cylinder, 18 in.; stroke 28"; heating surface of tubes, 936 sq. ft.; heating surface of fire-box, 109 sq. ft.; total heating surface, 1045 sq. ft.; grate area, 17 ¾ sq. ft.; weight on bogie, 17 tons; weight on trailers, 10 tons, 12 cwt.; total weight (full), 45 tons, 3 cwt.

Since the article was written, Mr. Sterling has designed six engines of this class, but more powerful than the one described. The bogie and driving-wheels are of the size named, but the cylinders have a diameter of 19 ¼ in. and 28 in. stroke. The steam pressure carried will be 175 lbs., and the engine and tender together weigh 90 tons.

Electrical Car-Heating.

THE RAILROAD GAZETTE (March 22) editorially enters into a comparison of the cost of electrical car-heating as compared with steam heating. All the items which enter into the cost of both systems, as interest on cost of apparatus, cost of repairs and attendance, and cost of fuel in the one case, and cost of power for generating the electric current in the other, are carefully considered, and the conclusion is reached that, while steam heating costs per car-hour 3.75 cts., when coal is $4.50 per ton, heating by electricity costs 10.7 cts. per car-hour, when the price of coal is the same, or a little more than three times as much as steam heating. An effort to be perfectly fair to electric heating is apparent in this article, and in some items, we think our contemporary has been more than fair.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Railway Affairs in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

30876. The Block System on the Chicago, Milwaukee and St. Paul. C. A. Goodnow (R R Gaz-April 12.) 1800 w.

30877. New York Central Track Elevation on Park Avenue. Ill. (R R Gaz-April 12.) 2000 w.

We supply copies of these articles. See introductory.

30880. The Webb and Thompson Train Staff System; C. M. & St. P. R'y. Ill. (Eng News-April 11.) 2500 w.

30885. Chicago City Railway Company Wrecks a Rival Company's Car. Ill. (W. Elec-April 13.) 1800 w.

*30924. The Revival of the "Single" Engine. Ill. W. B. Paley (*Ry Wrld*-April.) 1800 w.

30970. The Lenox Avenue Electric Conduit System of the Metropolitan Traction Company. Ill. (St Ry Gaz-April 13.) 2000 w.

30979. Cast Iron Chilled Car Wheels. William W. Lobdell (Ir Tr Rev-April 11.) 1800 w.

31051. Rebuilding Railway Works Without Stopping Traffic. Ill. (Eng News-April 18.) 800 w.

*31052. The Kuhlman Counterweight System at Providence. Ill. (St Ry Rev-April.) 900 w.

*31053. Rules and Discipline of Street Railways. H. S. Cooper (St Ry Rev-April.) 2800 w.

*31055. Steam Street Railways in Italy (St Ry Rev-April.) 1000 w.

*31056. Another "Home Made" Snow Plow. Ill. I. B. Walker (St Ry Rev-April.) 650 w.

*31057. War Against Connecticut Electric Roads (St Ry Rev-April) 4000 w.

31068. Hollerith's Electric Tabulating Machine. Ill. (R R Gaz-April 19.) 4400 w.

31069. Reorganization of Atchison. Editorial (R R Gaz-April 19.) 1800 w.

31070. A Case of Narrow Gauge. Editorial (R R Gaz-April 19.) 1600 w.

31071. The Permissable Strain on Draft Rigging. Editorial (R R Gaz-April 19.) 1300 w.

*31120. American Electrical Tramway Gearing. Ill. J. D. Dallas (*Elect'n*-April 12.) 1600 w.

*31131. The Transport of Fish by Rail (*Trans*-April 12.) 1200 w.

31142. The Electric Railway for Interurban Traffic. Ralph W. Pope (St Ry Gaz-April 20.) 2200 w.

*31145. Some Methods of Collecting the Energy in Electric Railways and Tramways. Holroyd Smith (*Elec Eng*-April 12.) 3500 w.

*31157. Railroad Signaling. Charles S. Churchill, with Discussion (Jour Asso Eng Soc-March.) 10400 w.

31159. Single Track Blocking on the Chicago, Milwaukee and St. Paul. C. A. Goodnow (Ry Rev-April 20.) 1800 w.

31160. Spring Rail Frogs. Ill. (Ry Rev-April 20.) 1300 w.

31161. Grade Crossings.—Bill Proposed by the Railroad Commission of the State of New York (Ry Rev-April 20.) 1800 w.

31162. The Relations of Railroad Men to Each Other and to the Public. George H. Daniels (Ry Rev-April 20.) 1200 w.

31163. Locomotive Smoke Stacks. Ill. Herbert M. Ramp (Foundry-April.) 1400 w.

*31181. Will the Electric Motor Supersede the Steam Locomotive. Joseph Wetzler (Scrib Mag-May.) 3300 w.

31191. The West Side Metropolitan Elevated Railway System of Chicago. Ill. (Sci Amer-April 27.) 1500 w.

31202. Shall a Street Railway Company Be Allowed to Use the Existing Tracks of a Competitor? Complaint at Chicago (W Elec-April 27.) 3000 w.

31207. The Physical Characteristics of the Lake Erie and Western Railroad (Eng News-April 25) 1500 w.

31209. Locomotives with More Than Two Cranks. Editorial (R R Gaz-April 26.) 1200 w.

31210. The Railroads of China. Editorial (R R Gaz-April 26.) 1800 w.

31214. Gas Motor Street Car Line in Dessau, Germany. Ill. Extract from the Jour. fuer Gasbeleuchtung (Safety V-April 15.) 600 w.

31218. Hard Times and the Railroads. Ill. A Staff Writer (Peterson Mag-May.) 3800 w.

31219. The American Locomotive. Ill. Charles W. Strine (Peterson Mag-May.) 6800 w.

†31235. Our Railroads in Default on Their Mortgage Bonds.—109 Roads, $976,022,865 Bonds (Bank Mag-April.) 2800 w.

*31251. The Great Dock Fight.—London vs. Southampton (*Fairplay*-April 19) 900 w.

*31254. The Rating of Railways.—Antiquated Methods (*Ry Times*-April 20.) 1800 w.

31265. Car Service Rules Coldly Considered. Observer (Ry Rev-April 27.) 1000 w.

31266. Track Elevation in Chicago.—Chicago and Northwestern Railway. Ill. (Ry Rev-April 27.) 2000 w.

31267. Timbering in the Ampthill Second Tunnel. Ill. Edward Ewing Matheson. Read before Inst. of Civ. Eng. (Ry Rev-April 27.) 2000 w.

*31271. The Grand Trunk Indictment (*Trans*-April 19) 1100 w.

31292. The Atchison Reorganization Plan. Editorial (Ry Age-April 26.) 1100 w.

*31296. The Railway Rates Decision. Editorial (*Engng*-April 19.) 1700 w.

31301. Great Railway Systems of the United States. Ill. J. B. Walker (Cos-May.) 3600 w.

*31339. English and American Railway Development. Editorial (*Ir & Coal Tr Rev*-April 19.) 1400 w.

*31347. Electric Traction. I. William Chubb (*Prac Eng*-April 19.) 2200 w.

†31350. The Madras Railway. Editorial (*Ind Engng*-March 23.) 1000 w.

*31361. The Need of a Change in Car Inspection. S. A. Charpiot (Loc Engng-May.) 700 w.

*31363. Standard Air Brake Freight Levers. B. Haskell (Loc Engng-May.) 1800 w.

*31364. Smoke Prevention. Editorial (Loc Engng-May.) 1600 w.

*31377. Locomotive Performances on Southern Pacific Railroad (Nat Car Build-May.) 1200 w.

We supply copies of these articles. See introductory.

31388. The Proposed Railway up the Jungfrau. Ill. (Sci Amer–May 4) 600 w.

*31400. The Use of Gas Engines for Tramways (*Jour Gas Lgt*–April 23) 1800 w.

*31419. Sand Shed at Hornellsville, New York, Lake Erie and Western Railroad. Ill. (Am Eng & R R Jour–May.) 1000 w.

*31421. The Great Siberian Railroad. Ill. (Am Eng and R R Jour–May.) 1600 w.

31431. Fast Run from Camden to Atlantic City, with Editorial (R R Gaz–May 3.) 1200 w.

31432. Freight Rates from Denver to San Francisco. Editorial (R R Gaz–May 3.) 1300 w.

31433. Rates for American Produce between Southampton and London. Editorial(R R Gaz–May 3) 1600 w.

†31435. The Street Railway System of Hartford, Conn. Ill. (St Ry Jour–May.) 4000 w.

†31438. The Function of a Reserve Fund in Street Railway Operation. Edward E. Higgins (St Ry Jour–May.) 3500 w.

31462. The Publication of Engine Men's Records on the Chesapeake and Ohio Railroad (Ry Eng & Mech–May.) 1000 w.

31463. Railways Do Not Always Get What They Buy.—Safeguards Suggested. Experience (Ry Eng & Mech–May.) 1000 w.

†31481. Efficiency Tests of the Urbana and Champaign Electric Street Railway. Ill. C. H. Trego and O. E. Goldschmidt (Tech–No. 9.) 6500 w.

†31482. Railroad Crossing Frogs. William D. Pence (Tech–No. 9.) 3000 w.

†31494. Investigation and Experiments for the Determination of the Groove in Guard Rails for Street Railways. Ill. V. Angerer (Pro Eng Club of Phila–April.) 4500 w.

†31496. Topical Discussion.—The Promotion and Improvement of Rapid Transit in Philadelphia (Pro Eng Club of Phila–April.) 4000 w.

*31513. The Gaisberg Rack Railway. Ill. (*Eng*–April 26.) 1200 w.

31545. Electric Railways as Freight Carriers. Editorial (Ry Age–May 3.) 800 w.

31546. Merchants Combine to "Boycott" Railways. Dallas—Tex.) (Ry Age–May 3.) 800 w.

31548. Locomotive Tools.—Discussion of New York Railroad Club. (Abstract.) (Ry Age–May 3.) 2000 w.

†31571. A Partial Solution of the Railway Problem. C. J. Buell (Arena–May.) 600 w.

31578. Prevention of Electrolysis by Trolley Currents. W. Stuart-Smith (Elec Wrld–May 11.) 1700 w.

31591. Extension of the Paris-Sceaux Railway. Ill. (Sci Am Sup–May 11.) 1100 w.

31605. An Instruction Car for Trainmen.—C. N. O. & T. Railroad. Ill. (R R Gaz–May 10.)1300 w.

31606. Duty of Railroads to Ice Perishable Freights. Editorial (R R Gaz–May 10.) 1300 w.

31607. The Anthracite Situation. Editorial (R R Gaz–May 10.) 700 w.

31608. Twelve-Wheel Freight Locomotives, Southern Pacific Railway. Ill. (Eng News–May 9.) 1200 w.

Serials.

17826. Evolution of the Air Brake. Ill. Paul Synnestvedt (Ry Eng & Mech–Began Dec., 1893—15 parts to date—15 cts. each).

24586. Railway Companies and Their Employes. O. D. Ashley (Ry. Age–Began Aug. 24, 1894—11 parts to date—15 cts. each).

28138. Block Signaling. Ill. W. H. Elliot (Loc Engng—Began Jan.–5 parts to date—30 cts. each).

28496. Electric Traction. Ill. Philip Dawson (*Engng*–Began Jan. 4—15 parts to date—30 cts. each).

28897. Motor Repairs. Ill. W. E. Shepard (St Ry Jour–Began Feb.—4 parts to date—45 cts. each).

29369. Tramway Management. By a Manager (*Ry Wrld*–Began Feb.—3 parts to date—30 cts. each)

29384. Street Railway Wheel Threads and Flanges.—Is a Standard Desirable? (St Ry Rev–Began Feb.—3 parts to date—30 cts. each).

29775. Yard Arrangements Along Heavy-Traffic High-Speed Railroads. A. Flamanche (Am Eng & Rail Jour–Began March—Ended May—3 parts—30 cts. each).

30158. Notes on Some French and Swiss Railways (*Ry Wrld*–Began March—2 parts to date— 30 cts. each).

30604. Locomotive Repair Shop Equipment. W. H. Weston (Nat Car Build–Began April—2 parts to date—30 cts. each).

30654. Electric Railway Repair Shops. H. P. Merriam (St Ry Jour–Began April—2 parts to date—45 cts. each).

30668. The People's Highways. Frank Parsons (Arena–Began April—Ended May—2 parts—45 cts. each).

30787. Light Railways in Belgium. Ill. (*Eng*–Began March 29—3 parts to date—30 cts. each).

31067. The Railroad Situation in California. Ill. By a Citizen of California (R R Gaz–Began April 19—Ended April 26—2 parts—15 cts. each).

31147. Mountain Climbing Railways. Ernest Scott (*Elec Eng*–Began April 12—2 parts to date—30 cts. each).

31158. Per Diem and Car Movements. W. E. Beecham (Ry Rev–Began April 20—Ended April 27—2 parts—30 cts. each).

31211. The Stresses in Car Axles (R R Gaz–Began April 26—2 parts to date—15 cts. each).

31264. The Railway Situation. Address of H. S. Haines, with Editorial (Ry Rev–Began April 27—1 part to date—15 cts).

31293. State Railways in Western Sumatra. Ill. (*Engng*–Began April 19—1 part to date—30 cts).

We supply copies of these articles. See introductory.

SCIENTIFIC MISCELLANY

Central American Rainfall.

A PAPER read before the Philosophical Society of Washington (March 2) by Mark Walford Harrington, and published in pamphlet form (*Bulletin*, Vol. III), not only contains a very exhaustive discussion of rainfall in Central America, but also presents many interesting facts relating generally to tropical rainfall. Tabulated results of observations are profusely given, and plates help to elucidate the subject. Some of the facts presented will be new to many readers.

"From Darien to Yucatan stretches a narrow, irregular land surface, washed on each side by a tropical sea. It extends through 10 degrees of latitude (8° north to 18° north), and is 1200 miles long by from 30 to 300 miles broad. It has an average width of 150 miles and a population of 18 per square mile,—a density closely equal to that of the United States as a whole, including Alaska, or that of Minnesota or Kansas. Through the center of this band runs a backbone of mountains, generally less than 10,000 ft. high, and for fully half of the distance less than 6000 ft., sometimes descending to moderate hills, at others expanding fan-shaped to form extensive plateaus of 3000 ft. or more. The coasts are rarely high, and along a considerable part of them is an area little above the sea level, marked by lagoons and floods. Generally this strip is narrow, but along the Mosquito Coast for a distance of 300 miles it has a breadth of 100 to 150 miles. The western versant is more rapid than the eastern."

"The rainfall in this region is typically tropical and follows the sun, giving a dry season when the sun is south of the equator and a wet season when he is north, and giving a maximum rainfall in or near the month when he is the zenith of the station of observation. This means two maxima per year; so that there are two rainy seasons, with a long and a short interval between them. The long dry season is in the months corresponding to our winter and spring, and is called the *verano*. It extends from December to April. The wet season is from May to November, and is called the *invierno*, while the short, drier season is in August, and is called the *veranillo* or little *verano*, also *verano de Augosto*."

Terms adopted by Mr. Harrington for indicating peculiarities of season are *verano* (long dry), *invierno* (wet), and *veranillo* (short dry). "Beginning with the height of the *verano*, in April, the weather is serene, clear, and the hottest of the year. On the plateaus it is delightful. With May or June the rainy season (*invierno*) sets in. It is due to local storms, with a striking diurnal course. The morning is cool and fresh. In the later hours of the forenoon cumulus clouds begin to appear about the mountain peaks, and are specially picturesque when hanging about volcanoes. They steadily grow and spread until cirrus streaks begin to extend from their tops, their bases become dark and threatening, and finally, late in the afternoon, the lightning flashes brilliantly, the thunder is loud and startling in its suddenness, and cataracts of water fall from the clouds. This lasts but a short time, and before one retires at night the sky is again clear and the stars remarkably brilliant. These thunderstorm phenomena gradually increase in daily duration and intensity, extending especially into the night, until the time of maximum rainfall in June. At that time it may begin to rain early in the afternoon and continue all night. The thunderstorms then decrease to the *veranillo*, at which time they may cease entirely for a few days or weeks. They begin again after it, and reach a second maximum in October, when they gradually decrease until December. The rainfall phenomena, though short and intense, are very local in area and have marked limitations in time. Their intensity is largely a question of topography and wind. Hence

the most marked and striking variations exist, similar to those of local storms elsewhere, but more marked in character. Hence also marked localization of rainfall. A few rods will sometimes make one pass from within a torrential rain to a spot without rain. Hence also remarkable variations in the rainfall from year to year, or in the same month of successive years, or in the monthly rainfall at adjacent stations."

A remarkable periodicity in the amount of a rainfall is apparent from observations made from 1856 to 1893. The maximum rainfalls have occurred in 1856, 1861, 1866-7, 1872, 1878-9, 1886-7, and 1893; from which it appears that these periods of maximum have an interval not far from 5 years on the average, although two of the intervals noted were respectively 6½ and 8 years. The greatest annual rainfall is at Greytown, where it reaches the enormous total of over 20 ft.,—a figure surpassed in America only on the Gulf coast, in the West Indies, Guiana, and on the coast of Brazil. The next greatest rainfall is in Alta Verapaz, and the smallest is along the upper plateaus in most of Central America proper, but more toward the southern coast in the Isthmus region. The maximum rainfall is not near the sea level, but at an elevation of about 2500 ft.

The great violence of some of the rain storms is shown by the fact that from 7 to 10 per cent. of the annual fall has been observed to descend in a single day. "The results of such enormous falls of rain have often been described, and can easily be imagined. The dry stream-beds or quebradas, very common on the plateaus, are rapidly filled; the water comes down in a wall several feet high; the camping place, hastily sought in the dark, and several feet higher, is also overflowed. In such a country as Mosquitia dry stream-beds become rivers, marshes change to lakes, and the natives temporarily take to the trees or to their boats." Such rains are, however, not without parallel in temperate regions; "7.5 in. in a day is no great rarity in the United States, while the Gulf and Atlantic coasts are subject to occasional falls of 10 in. in one day, and Boise, Idaho, once reported 18 in." In a footnote it is stated that probably the greatest rainfalls ever recorded are described in *Nature*, Vol. xlviii, pp. 3 and 77. One of these was at Crohamhurst, Queensland, Australia, where in 1893 there fell 35.7 inches in 24 hours. On June 14, 1876, in Chirapunji, British India, 40.8 inches in one day were reported by Mr. E. Douglas Archibald.

"These conditions are especially interesting from the standpoint of the possible ship-canals in Central America. Though the information is scanty, it appears to have been such a rainfall in 1887 which began the disasters of the Panama canal. It must be acknowledged that the conditions at Suez, Sault Ste. Marie, and the Welland canal are in this respect very favorable, for with them the question of sudden floods does not enter. It enters in the case of the great ship-canal of St. Petersburg-Cronstadt and of those of the Ganges-Brahmaputra delta, but in these cases there are no changes of level sufficient to make the use of locks necessary. Indeed, the use of locks on ship-canals whose feeders are subject to sudden and violent floods appears to present a new engineering problem, first met in the Panama canal."

Manufacture and Uses of Pulverized Charcoal.

TO many the statements that the manufacture of pulverized wood charcoal is an organized industry, and that this material has important industrial uses, will be new. The use of bone-black (the charcoal of bones) in refining sugar and other materials has long been practised, and is well known to most well-informed people, but that wood-charcoal has analogous industrial applications of sufficient importance to require its systematic production on a commercial scale is probably not so widely known.

Carbon in the form of charcoal, whether made from bones or wood, is a powerful absorbent of substances which in many refining processes constitute the impurities it is desired to remove. Bone-black is preëminently an absorbent of gases, water, and certain coloring principles. If good, freshly-calcined bone-black be exposed to

air, it will absorb many times its own volume of the gases present in the atmosphere. Its attraction for water is, however, so much greater than its attraction for gases that, if, after standing in air for some time, it be covered with water, the water will expel the gases which escape with such activity through the supervening water as to give the latter the appearance of boiling; and this agitation of the water will continue till the gases have all been displaced. When bone-black is exposed to heat in a vessel or retort having an opening for the escape of the absorbed gases, the latter are also expelled, and the material is thus again fitted to act as an absorbent. It is thus that bone-black is renovated in sugar-refineries where it is used over and over again; but in this case the materials expelled in the renovating process are water and the impurities it has extracted from the syrups before the latter have been concentrated to the point of saturation. Wood charcoal has the same properties in a less degree, and it is used for purifying water, wines, glycerine, and other liquid substances. *Scientific American* (April 13) devotes a page to an illustrated description of the manufacture of pulverized wood-charcoal.

The lump charcoal "is bought by the car-load by the manufacturer, who first extracts the gas from the coal by reburning it in kilns, after which the material is passed through a cracking, softening, and grinding process, which produces any grade of charcoal, ranging from flour to pieces as large as peas. The kilns are made of ½-in. boiler-plate iron. They are about 10 ft. in height and about 6½ ft. in diameter inside, and are lined on the interior with fire-brick. Each kiln is pierced with about eighteen draught holes 4 in. in length and about 3 in. in height. A wood fire is started in the bottom of the kiln, and about two or three barrels or bags of lump charcoal placed on it. As soon as the coal becomes red-hot, a little more of the material is added, the operation being continued until the heated charcoal reaches up above the draught hole. The door of the kiln is then plastered up, the stopping of the draught below preventing the charcoal on the bottom from going to ashes and also causing it to gradually cool and retain the same form as before burning. As fast as the fire ascends through the charcoal, fresh layers are thrown into the kiln from the top by the attendants, the draught holes being stopped up with plaster as fast as the material becomes red-hot above each opening. The kiln holds about 70 barrels of charcoal. The top of the kiln is bricked over, with the exception of a circular opening about 2½ ft. in diameter in the center. After burning for about 12 hours, a circular piece of sheet iron is placed over the opening, which smothers the fire, the gas escaping by means of a small hole in the center of the plate."

This part of the process occupies about 48 hours,—from the time of firing up till the material can be cooled off and discharged from the bottom of the kiln. The coal is then cracked in a machine called the "cracker," whence it is passed to a grinding mill consisting of a runner stone revolving over a bed stone, almost exactly modelled after the old-fashioned grain mill. The ground material is screened, and the coarser particles thus separated are returned to the mill to be reground. Another kind of mill for grinding, used for some grades of the product, is a revolving iron cylinder containing iron balls which pulverize the material by rolling upon it. One firm in New York, engaged in this manufacture, is stated to make an output of about half a ton per hour, which is packed in bags holding about 78 lbs. each, this being the form in which it enters into industrial commerce.

Carbon Dioxid as a Refrigerant.

PREMISING that ammonia is not well adapted to refrigeration from central stations, except for small districts, and that its elements of failure are (1) the recovery of the expanded ammonia through return pipes which are far more expensive than the supply pipes, and (2) the difficulty of equitably metering the supply, M. E. F. Osborne contributes to *The Journal of the Association of Engineering Societies* a scheme for central-station refrigeration with carbon dioxid. This gas, after being

liquefied under great pressure, in regaining the gaseous condition absorbs heat from surrounding objects, and its latent heat of vaporization is large enough to render it exceedingly effective as a refrigerant. When released from pressure and unable to get heat from other bodies, a portion of it volatilizes at the expense of the heat in the mass, the temperature of which thus falls rapidly enough to freeze what is left after the evaporation. This frozen material thereafter slowly liquefies, and then vaporizes by extracting from warmer contiguous bodies the heat necessary to change it successively into a liquid and gas. It is claimed that it can be made so cheaply that it is not worth while to attempt its recovery or to use it more than once, provided it be made in large quantities by a special process, in a plant properly designed for the purpose.

Carbon dioxid is also one of the most efficient means of extinguishing fires. Its utilization for putting out fires in buildings would entail only a trifling cost in connection with its employment as a refrigerant. It has long been used in portable fire extinguishers, but not in the liquid form. The liquid can only be maintained as such by subjecting it to very great pressure, and in this fact will be found, we think, the origin of many and serious practical difficulties in carrying out Mr. Osborne's proposed scheme. However, the resources of engineering in the management and retention of liquids and gases under high pressure have been greatly enlarged within a few years, and it is by no means impossible that pipes, valves, and fittings can be supplied that will meet the requirements of the system. We quote a description of the plant and process.

"The system consists of a central station provided with one or more gas-producers, calcining retorts, distilling apparatus, boilers, engines, pumps, compressors, and incidental apparatus. The raw materials required are soft coal and limestone. The products are carbon dioxid, commercial lime, carbonate of ammonia, and coal tar. The coal is supplied to retorts, and subjected to destructive distillation, in nearly the same manner as in ordinary gas works, the tar and ammoniacal liquor being separated, the former being sold in that state, and the latter distilled and converted into carbonate of ammonia, packed, and sold. The coke is converted into a semi-water gas, which is used to calcine the limestone. The lime produced is of the best quality, and is sold on the open market either in bulk or by the barrel. The dioxid is purified, cooled, compressed, and liquefied in the same way as is done in ordinary manufactories where this substance is produced for commercial purposes. The liquid dioxid then passes by its own pressure into the main distributing pipes in the street. At the curbstone is a service cock; just inside of the consumer's premises is an automatic valve, which cuts off the supply in case of a break or careless management of the apparatus on the consumer's premises; if the break is permanent, or anything has happened equal to a rupture of the service pipe, the supply remains substantially shut off. When the damage is repaired and normal conditions are established, the supply is automatically turned on. From this valve the dioxid passes to a meter, thence to the automatic regulating valve in the refrigerator, which is set to maintain any temperature desired, from which valve the dioxid is conducted into the cooling chamber or coil located in the space to be cooled. Thereafter the dioxid in gaseous form may be used to charge drinking water, ale, beer, or wine, and for forcing these other liquids from a lower or higher level, as from the basement of stores and restaurants to any floor above; or the gas can be used for preservation of nearly all kinds of food products, where a low temperature is not necessary, especially for fruits, vegetables, and meats. It can also be used for small powers, and the heat that is extracted from the substances cooled goes a long way towards furnishing the motive power required in connection therewith.

"Briefly, the services above referred to are to be furnished from a central station, somewhat similar to a gas or water-works plant, and the carbon dioxid, after its production, delivered into flasks or cylinders for use on board cars, ships, or at other

places not directly connected with the central station. Or the dioxid is delivered into a ramification of pipes leading to the premises of the various consumers, where it is metered, automatically regulated, and the resulting gas allowed to go to waste.

"One ton of good soft coal and 3½ tons of limestone will produce rather more than 3,500 lbs. of lime, 3,000 lbs. of carbon dioxid, 6 to 7 gallons of coal tar, and 40 lbs. of carbonate of ammonia."

The Artificial Spectrum Top.

A SCIENTIFIC toy has lately attracted considerable attention in England, and will, doubtless, ere long make its appearance in America, if, indeed, it has not already arrived. A top in which the motion of white and black spots or tracings produces a succession of spectrum colors is, to say the least, a scientific puzzle, and it may be that it sets a problem well worthy of a scientific solution. A plausible theory of this curious effect is given in *Engineering* (April 19) by Mr. Charles Benham, who was the first to set the subject conspicuously before the public eye by placing such tops on the market through a London firm.

The origin of this toy, which may soon take rank among apparatus in physical laboratories, was in a remarkable invention of Mr. Benjamin W. Betts, formerly of Auckland, New Zealand. Mr. Benham says of Mr. Betts that he is a man "of somewhat remarkable philosophy, in which are strangely mingled science, astrology, and a species of mysticism. He has worked out a very singular theory as to flower forms and the geometrical laws which govern them. In carrying out his investigations he was led to expect that by rotary motion his geometrical diagrams ought to show the coloring of leaves and flowers, and in experimenting with this end in view he actually realized his expectations, and found that the cardboard discs which he employed,—discs of various shapes with mysterious slits and loppings in accord with his strange Fichtean doctrines,—when set revolving against a dark background, gave distinct coloring effects. I was much astonished at the instrument, and set to work with my compound pendulum curves to see if they could be adapted to the principle of the chromoscope. I soon found that they could, and I followed up these experiments with innumerable others, with a view to solve the mystery, if possible. After trying every imaginable variation of form and arrangement, I at last hit upon the simple idea of a top with eccentric lines of black on a disc half black and half white. The effect was better than Betts's chromoscope, and the form of the disc I found to be more effective than any other I was able to devise. As, however, I am still frequently being asked whether I have ever tried such and such modifications,—white lines on black, shorter lines, thicker lines, colored lines, &c.,—I may take this opportunity of saying that I think there can hardly be any arrangement of this sort that I have not tested carefully."

One Mr. Jewsberry is said to have made a very similar discovery some years ago, but he did not carry it to a conclusion, and Mr. Benham claims that there is no connection between Mr. Jewsberry's experiments and his own. The top, as now constructed, "consists of a revolving disc, half black and half white. On the white half are short concentric arcs of black. When the top revolves close under a bright lamp, these arcs appear, not as grey lines, as might be expected, but as lines of color. To most eyes the effect is as follows:

"(1) when the revolution is such that the black line is preceded by the black half of the disc and followed by the remainder of the white, it appears red; (2) when the direction of rotation is reversed, it appears blue; (3) when the lines are on the central portion of the white (so as to have equal white immediately on each side), the color is green; (4) intermediate positions give approximately the intermediate colors of the spectrum. A few people see the colors differently, and one or two people, by no means color-blind, can see no color at all. Curiously enough, I know of two people who are somewhat color-blind, but can see the colors on the top very well."

The explanation given by Mr. Jewsberry

is accepted by Mr. Benham,—to wit, that these color effects are purely subjective and physiological. "There is no difference of actinic power in the bands involved in the red way or the blue way. Further, with a bright sodium flame, though practically monochromatic, the colors are very distinct." The hypothesis is that the rapid alternation of white and black lines sets up in the retina the same vibrations as the actual colors do, and that thus the color sensations are produced. Mr. Benham acknowledges that this is only a clue, and thst it does not completely solve the mystery.

Mars a Disappointment.

IT is feared that we shall have to abandon all our ideas of the planet Mars that have hitherto made such pleasant food for the imagination, and have furnished so many sensational items for the newspapers, Profs. Campbell, Schaeberle, Barnard, and Holden have been pointing their telescopes at this ruddy orb during the whole period of its opposition, with results that dispel all dreams that it is inhabited. According to Prof. E. C. Holden in the *North American Review* for May, there is no atmosphere to speak of, and no water, on the surface of Mars, and it is therefore inferentially as barren of life as that of the moon is inferred to be from its telescopic aspect. Says Prof. Holden: "The moon has no atmosphere, or, at all events, an indefinitely thin atmosphere. If, then, we compare the spectrum of Mars and the moon (under proper conditions as to altitude, etc.), and if we find them unlike, the unlikeness is due to the absorption of a Martian atmosphere. If, on the other hand, we find them like, then Mars has no atmosphere, just as the moon has none. Such is the principle of the method which Professor Campbell has carried out at the Lick Observatory during the past summer, taking every precaution to exclude all sources of error. He was unable to detect any difference between the spectrum of Mars and that of the moon under like conditions. That is, Mars has no more atmosphere than the moon, so far as this method is sufficient to detect one. There is no more evidence of aqueous vapor in the atmosphere of Mars than in the no-atmosphere of the moon. The method employed is delicate, but it is not perfectly and absolutely so. An atmosphere one-fourth as extensive as our own would certainly have been detected, and very probably an atmosphere much less extensive than this. The atmosphere of Mars, if indeed it has any at all, must be at least as thin as, probably very much thinner than, that of the highest peaks of the Himalayas."

Now this statement involves the absence of many other things that have been popularly believed in,—"the lakes, oceans, canals (of water), the snow-storms, inundations, inhabitants (like ourselves), and the signals they were making us, etc., etc.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Various Scientific and Industrial Subjects in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

†30842. Central American Rainfall. Ill. Mark Walrod Harrington (Philosophical Soc of Washington–March 2.) 6500 w.

30871. The Future of Fertilizers. A. D. Ledoux (Mfrs Rec–April 12.) 900 w.

30873. A Plea for a Science. W. S. Crosby (Elec Engng–April.) 3500 w.

30888. The Educational and Industrial Value of Science. Henry S. Carhart (Sci–April 12.) 5000 w.

30901. The Pulverized Charcoal Industry. Ill. (Sci Amer–April 13.) 800 w.

*30942. The Age of the Earth. W. J. Sollas (*Nature*–April 4.) 1200 w.

*30043. Professor Mendeléeff on Argon (*Nature*–April 4.) 1000 w.

*30944. Precious Stones, and How to Distinguish Them. H. A. Miers (*Nature*–April 4.) 4500 w.

30986. What is Glass? R. Helmbacher (Am Man & Ir Wld–April 12.) 500 w.

†30990. A New Law of Geographical Dispersal. Charles Dixon (*Fort Rev*–April.) 9300 w.

31041. The Advantages of the South in Cotton.—Opinions of Edward Atkinson (Tradesman–April 15.) 3300 w.

31077. Argon. Experiments of M. Berthelot (Sci–April 19) 700 w.

*31119. Professor Baldwin Brown on the Arts and Crafts (*Brit Arch*–April 12.) 1200 w.

*31173. Carbon Dioxide for Refrigeration and for Extinguishing Fires. (Extract). E. F. Osborne (Jour Asso Eng Soc–March.) 1600 w.

We supply copies of these articles. See introductory.

*31177. The Dimensions of the Universe. Garrett P. Serviss (Chau-May.) 3500 w.

31220.—$1. Korea and the Koreans. In the Mirror of their Language and History. William Elliot Griffis (Bul Geog Soc-Vol XXVII, No. 1.) 9000 w.

31221. The Fine Art Confederation. Editorial (Arch & Bldg-April 27.) 1100 w.

*31253. My Recent Voyages in Siberia. Captain Wiggins, with Discussion (*Jour Soc of Arts*-April 19.) 7000 w.

*31263. Australasian Timbers. From "The Year Book of Australia" for 1894 (*Brit Arch*-April 19) 1100 w.

†31275. The Progress of Meteorology. Frank Waldo (N Amer Rev-May.) 3300 w.

†31277. The Latest News of Mars. Edward S. Holden (N Amer Rev-May.) 1300 w.

*31279. Mechanical Equivalent of Light. A. F. Ravenshear (*Elec Rev*-April 19) 1100 w.

*31299. The Artificial Spectrum Top. Charles Benham (*Engng*-April 19.) 1300 w.

†31302. Archæology in Denmark. Ill. Frederick Starr (Pop Sci M-May.) 3500 w.

†31303. The Work of the Naturalist in the World. Charles Sedgwick Minot (Pop Sci M-May) 6500 w.

*31308. The Free Public Library. H. H. Barber (Am Mag of Civ-May.) 6000 w.

*31311. The Growth of Peace Principles, and the Methods of Propagating Them. Belva A. Lockwood (Am Mag of Civ-May.) 5000 w.

*31312. Distinctive American Citizenship. Adolph Roeder (Am Mag of Civ-May.) 2800 w.

*31314. State Rights and Federal Encroachments. James S. Fisher (Am Mag of Civ-May.) 4000 w.

†31321. James Dwight Dana. Ill. E. S. D. (Am Jour of Sci-May.) 8500 w.

†31322. On the Color Relations of Atoms, Ions and Molecules. M. Cary Lea (Am Jour of Sci-May) 5000 w.

†31323. Further Notes on the Gold Ores of California. H. W. Turner (Am Jour of Sci-May.) 2000 w.

†31324. On Some Relations Between Temperature, Pressure and Latent Heat of Vaporization. C. E. Linebarger (Am Jour of Sci-May.) 4800 w.

†31325. On the Double Halides of Caesium, Rubidium, Sodium and Lithium with Thallium. J. H. Pratt (Am Jour of Sci-May.) 1500 w.

†31326. Argon, Prout's Hypothesis, and the Periodic Law. Edwin A. Hill (Am Jour of Sci-May.) 4800 w.

*31408. The Production of India-Rubber in British India (*Bd of Tr Jour*-April.) 1100 w.

31415. Water on the Planet Mars. (Extracts) Camille Flammarion (Lit Digest-May 4.) 1200 w.

†31439. The Law of Mass Action. J. E. Trevor (Am Chem Jour-May.)500 w.

*31441. A Plea for Contractors. Charles A. Ewing (Paving-May.) 2500 w.

31474. Facts About Glass.—The Material in Use Thousands of Years Ago (Bos Jour Com-May 4.) 1200 w.

†31485. Mathematics and Construction in "The École des Beaux Arts." James M. White (Tech-No 9.) 2500 w.

†31487. The Proximate Analysis of Coal. S. W. Parr (Tech-No 9.) 1000 w.

†31492. Address of John C. Trautwine, Jr. (Pro Eng Club of Phila-April.) 17000 w.

†31493. The United States Geological Survey and its Methods of Work. Charles D. Wolcott (Pro Eng Club of Phila-April.) 6400 w.

*31550. An Improved Method for the Microscopic Investigation of Crystals. A. E. Tutton (*Nature*-April 25) 3800 w.

†31599. Climatic Conditions Shown by North American Interglacial Deposits. Warren Upham (Am Geol-May.) 7500 w.

†31600. The Eruptive Epochs of the Taconic or Lower Cambrian (Am Geol-May.) 2800 w.

†31601. The Nipissing Beach on the North Superior Shore. F. B. Taylor (Am Geol-May.) 3000 w.

†31602. Central Iowa Section of the Mississippian Series. H. Foster Bain (Am Geol-May) 2500 w.

†31614. Rubber in the Congo Region and East Africa. Letters from Charles J. Zingg and J. H. Camp, with Notes (Ind Rub Wld-May 10.) 2500 w.

†31615. Dissolution of the Rubber Reclaiming Company (Ind Rub Wld-May 10.) 800 w.

Serials.

24462. Graphic Statics. W. W. F. Pullen (*Prac Eng*-Began Aug. 10, 1894—17 parts to date—30 cts. each).

27198. Refrigeration and Ice-Making (Sta Eng-Began Nov., 1894—5 parts to date—15 cts. each).

28838. The Contributions of Chemistry to the Methods of Preventing and Extinguishing Conflagrations. Thomas H. Norton (Jour Am Chem Soc-Began Feb.—3 parts to date—45 cts. each).

29531. A History of the Last Quarter Century in the United States. Ill. E. Benjamin Andrews (Scrib Mag-Began March—3 parts to date—30 cts. each).

30858. The Natural Soda Deposits of the United States. Thomas M. Chatard (Jour Fr Inst-Began April—Ended May—2 parts—45 cts. each).

31006. Geological Development of the Australian Continent. A. C. Gregory (*Aust Min Stand*-Began Feb. 23—Ended March 9—3 parts—30 cts. each).

31105. Technical Chemistry. F. W. Streatfield (*Chem Tr Jour*-Began April 13—Ended April 20—2 parts—30 cts. each).

31336. British Fuses for Modern Guns. Ill. (*Eng*-Began April 19—1 part to date—30 cts).

BOOKS OF THE MONTH

THE STANDARD DICTIONARY OF THE ENGLISH LANGUAGE upon original plans designed to give, in a complete and accurate statement, in the light of the most recent advances in knowledge, and in reduced form for popular use, the orthography, pronunciation, meaning, and etymology of all the words and the meaning of idiomatic phrases in the speech and literature of the English speaking people. Prepared by more than two hundred specialists and other scholars under the supervision of Isaac K. Funk, D. D., editor-in-chief, Francis A. March, LL. D., Ph. D., consulting editor, Daniel S. Gregory, D. D., managing editor. Associate editors, John Denison Champlain, M. A., Rossiter Johnson, Ph. D., LL. D., Arthur E. Bostwick, Ph. D. Volume II. M. to Z. New York, Funk & Wagnalls Co.; London and Toronto, 1895. Printed in the United States. [2318 pp., "9×12," full morocco and gilt.]

IN estimating a work of this kind at its true value, the exercise of caution with judgment is needed. The publishers have sent it out to reviewers accompanied by prepared reviews evidently with a purpose to form favorable opinion in advance of critical examination. The ostensible object of sending these reviews, as announced, is to aid reviewers in a task which, if adequately performed, would involve much time and labor in examination, and comparison. As in this review we must imitate what in the dictionary itself appears to be almost inimitable in degree, the feat of compressing into word-space the very ultimate of meaning it can contain, we can only give the impression made by a careful comparison of the claims of the publishers with what they have achieved.

The principal features and claims are substantially as follows: (*a*) Unprecedented comprehensiveness in the vocabulary. (*b*) The ordinary meanings of words have first place in definitions. Etymology follows definition,—the proper and logical place for it. (*c*) Differences in spelling and pronunciation in cases where current practice differs have been referred to an advisory committee of able philologists who have authoritatively established the best modern usage. Geographic names follow in their orthography the decisions of the U. S. Board on Geographic names. The spelling of chemical terms has been simplified in deference to the desire of the chemical section of The American Association for the Advancement of Science. (*d*) The modern drift toward simpler spelling has been allowed due weight, without overstepping the limits of practicability, and in all cases of dipthongal forms still much used, both the simplified spelling and that hitherto employed are given, the simplified spelling taking precedence. Differences of American and English usage in words like labor (English, *labour*), etc., are recognized by giving both forms a vocabulary place, the simpler form taking precedence. (*e*) Pronunciation has been indicated by the use of the scientific alphabet, used by the American Philological Association and adopted by the American Spelling Reform Association; and this is justly held to be a more accurate method of indicating pronunciation than has before been adopted in a dictionary. (*f*) Words coined at the caprice of authors and in their nature not likely to enter permanently into the language, have been rigidly excluded, not by the decree of a single editor, but after careful consideration by a committee of representative scholars. (*g*) The definitions are thorough, all such as in the sciences, the arts, and the professions, required special treatment having being referred to trained specialists in the science, art or profession to which they relate. (*h*) An improved treatment of synonyms and antonyms has been adopted. (*i*) Ample exemplifications of the correct use of prepositions are given;—a very useful feature, especially to foreigners desiring to speak and write English with propriety. (*k*) An attempt, (the difficulty of which can hardly be appreciated except by professional editors) has been made to reduce compounding of words to a scientific system. No previous effort to do this in a dictionary has succeeded, though it has been feebly essayed with varying degrees of failure. The use of the German double

hyphen for compounded words in place of the single hyphen, reserving the latter for divided simple words, is a commendable feature that might advantageously be imitated in all printing. (*l*) A system of grouping has been used whereby, under the name of some leading word, e. g., "*coin*," "*constellation*," etc., a vast amount of fact is compressed into a minimum of space; we have already spoken of this feature as unprecedented in the manner of its execution and seemingly almost inimitable. (*m*) Syllabication is based upon pronunciation, as a rule for the division of words at ends of lines in writing and printing; — the only rule that can secure uniformity in this respect.

Aside from the claims made for superior pictorial illustration, typography, and binding, which are easily verified by the eye of any competent judge of merit in these arts, the above are the principal features upon which claims for the superiority of the work are based, and the bare statement of them indicates that the publishers commenced the work with perfectly clear and comprehensive ideas of what an English dictionary ought to be, and what it could be made with a sufficient amount of talent, time, and expenditure.

Has it realized the ideal? Doubtless the publishers themselves would candidly admit that there are some points in which they have failed to accomplish their task to their entire satisfaction. The realization of a high ideal is always difficult. But, after very careful examination, with the special object to discover whether the claims are justified in the work itself or not, we are compelled to join in the general outburst of approval which this book has met from scholars and critics in all English speaking lands. In doing this, we candidly confess that a kind of affection for other dictionaries, born of long acquaintance and use, has somewhat obstructed the formation of the opinion we have expressed, and we might perhaps have been more pronounced in its expression, had it not been for a reluctance—probably felt at times by all book-lovers—to let new friends usurp the place of old ones.

The vast learning, minute painstaking, and careful supervision that have been focused upon the preparation of this work, is evident on every page and in every definition. Only a most rigidly enforced system, governing every one concerned in its production could have resulted in so large a measure of success.

ELEMENTS OF MECHANICAL DRAWING. USE OF INSTRUMENTS, Geometrical Problems and Projection. By Gardner C. Anthony, A. M., Professor of Drawing in Tuft's College, Dean of the Bromfield-Pearson School, Member of Am. Soc. of M. E. Boston, U. S. A.: D. C. Heath & Co., 1894. [98 pp. 7½″×5½″ and 32 folding plates 15″×5½″. Price $1.50.]

A SERIES of exercises better adapted for use in schools as a text-book for instruction in geometrical drawing than as an aid to more advanced pupils in mechanical drawing. The examples are mostly geometrical. The subject of projection is well treated in the text, and the same may be said of other parts of the treatise, although its scope is somewhat limited.

BOOKS RECEIVED.

J. J. Crawford, State Mineralogist, State Mineralogist.=12th Report of the State Mineralogist (Second Biennial), Two Years, ending September 15, 1894. California State Mining Bureau. Sacramento: A. J. Johnston, Supt. State Printing, 1894. [Octavo, 551 pp., flexible covers.]

New York Railroad Club. Proceedings of the meeting held Thursday evening, March 21st, 1895. Topical discussion. [18 pp., 6″×9″, paper.]

City Engineer's Report, 1894, Binghamton, N. Y. S. E. Monroe, City Engineer. [17 pp., 6″×9″, paper.]

University of Wyoming, Laramie, Wy. Departments of Chemistry and Chemical Engineering. Special bulletin, January, 1895. The Heating Power of Wyoming Coal and Oil, with a description of the Bomb Calorimeter. By Edwin E. Slosson, Professor of Chemistry and L. C. Colburn, Professor of Mechanical Engineering.

Brakes for Light Railways, being a discussion of Question XX at the 5th Session of the International Railway Congress, London, 1895. [33 pp., 7″×10″, paper.]

Boilers, Fire-backs and Tubes, being a discussion of Question V discussed at the International Congress, 5th Session, London, 1895. Reprinted from the Congress Bulletin. [74 pp., 7″×10″, paper.]

New York Railroad Club. Constitution and By-laws and list of members, published by the club. John A. Hill, Secretary, 256 Broadway, New York. [14 pp., 6″×9″, paper.]

The Decimal System, being Question XVI discussed at the 5th Session of the International Congress, London, 1895. Reprinted from the Congress Bulletin. [12 pp., 7″×9½″, paper.]

Light Railway Shops. Question XIX discussed at the 5th Session of the International Railway Congress, London, 1895. Reprinted from the Congress Bulletin. [10 pp., 7″×9½″, paper.]

The Twenty-four Hours Day, being question XV discussed at the International Railway Congress, London, 1895. Reprinted from the Congress Bulletin. [15 pp., 7″×9½″, paper.]

Organization. Question XIII discussed at the International Railway Congress, London, 1895. Reprinted from the Congress Bulletin. [13 pp., 7″×9½″, paper.]

Station Working. Question X discussed at the International Railway Congress, London, 1895. Reprinted from the Congress Bulletin. [61 pp., 7″×9½″, paper.]

Duty Trial of the Pumping Engine for the Louisville Water Company, Louisville, Kentucky. By F. W. Dean, Boston. Reprinted from Volume XVI of the transactions of the American Society of Mechanical Engineers, together with reports of experts. [63 pp., 6″×6″, paper.]

Statistics of the American and Foreign Trades for 1894. Annual statistical report of the American Iron and Steel Association containing complete statistics of the American Iron Trade for 1894; also a brief review of its present condition; also complete statistics of the iron ore, coal, pig iron and steel industries of the United States and of all foreign countries for a long term of years. Presented to the members May 15th, 1885, Philadelphia. The American Iron and Steel Association, No. 261 South Fourth St., 1895. [99 pp., 6″×9″, paper.]

25th Annual Report of the Board of Directors of The Lake Shore and Michigan Central Railroad Company for the fiscal year ending Dec. 31st, 1894, Cleveland, Ohio. The Munhall Brothers Company, 1895. [39 pp., 6″×9″, paper.]

The Railroad as an Element in Education. An address before the International Congress of Educators, World's Exposition, New Orleans, by Prof. Alex. Hogg, M. A., Superintendent Public Schools, Fort West. Edition of 1892 with addenda. Louisville. Printed for the author, 1892. [69 pp., 6″×7½″, paper.]

Report of the City Engineer of the City of Troy, for the two years ending February 28th, 1895, including the work done under the inspection of the public improvement commission from the date of its Third Annual Report, February 28th, 1893, to the time of the abolishment of the Commission and the merging of its work into the City Engineer's Department, June 30th, 1893. By Morris R. Sherrerd, City Engineer. [54 pp., 6″×9″, and one folding map showing existing sewers, and granite, brick and asphalt pavement to accompany engineer's report, and six folding sheets containing tables of dimensions, cost of work, and other statistical information.]

New York Railway Club. Discussion of the Chicago plan of Interchange. Meeting of April 18th, 1895. Published by the Club, John A. Hill, Secretary, 256 Broadway, New York. [17 pp., 6″×9″, paper.]

Boiler Review. A publication issued for the perusal of those interested in Steam Boilers, in which are technically reviewed theory and practice relating to the design, construction and application of stationary, marine and locomotive boilers with a view of helping those connected with their use or purchase to form an opinion as to the merits and demerits of all boilers, unbiased by certain prejudices due to erroneous assertions and claims made in behalf of many constructions. Hogan Boiler Co., Middletown, New York, U. S. A. [196 pp., 7″×9″, paper.]

The Transporting Power of Water as Applied to the Deepening and Improvement of Rivers, with a description of "The Eroder" by W. H. Wheeler, M. Inst. C. E. Boston, J. M. Newcomb, 1895. [20 pp., 5½″×8″, paper.]

Report on the Chicago Strike of June-July, 1894, by the United States Strike Commission Appointed by the President, July 26th, 1894, under the Provisions of Section 6 of Chapter 1063 of the Laws of the United States, Passed October 1st, 1888: With Appendices Containing testimony, proceedings and recommendations, Washington Government Printing Office, 1895. [681 pp., 5¾″×9″, paper.]

13th Annual Catalogue of the Rose Polytechnic Institution, Terre Haute, Ind., with an outline of the course of study and a plan of instruction, 1895. Terre Haute, Ind., Moore & Langdon, 1895. [68 pp., 5⅝″×8½″, paper.]

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

C. W. Hunt Co., New York, U. S. A.=Pamphlet, 40 pp., 6¾″×9½″. [Gives complete information as to the construction, value and advantages of Industrial Railways for manufacturing establishments. Discusses the topics of what gage is best, what radius curves should be used, how heavy the rail should be, what style will be best, what kind of cross-ties should be used, how switches and crosses should be made, the advisability or unadvisability of turn-tables, the effect of crosses, etc., etc. The whole is thoroughly illustrated with details of construction and will convey all needed information to those who contemplate the construction of this class of railways. Cover, chocolate brown and gold.]

The Short-Conrad Co., Cleveland, Ohio, U. S. A.=Pamphlet, 8 pp., 8″×5¼″. [Describes and illustrates construction and application of the "National" temperature regulator for steam or hot water heaters.]

The Commercial Electric Co., Indianapolis, Ind., U. S. A.=Unpaged sheets eyeletted together. [Illustrations and descriptions of motors, dynamos, power and railway generators. Elegantly printed: cover, pearl-grey and green.]

The Plume & Atwood Manufacturing Co. New York, U. S. A.=Catalogue, 64 p. [Describing a long line of brass and copper good, which it requires two pages to index. Goods illustrated as well as described, and in great variety. Elegantly bound in indigo, blue, and gold; flexible cover with rounded corners.]

Hine & Robertson Co., New York, U. S. A. =Catalogue, unpaged. [Steam specialties, including indicators, reducing wheels, and chronometers; with price-lists and illustrations.]

Randolph & Clowes, Waterbury, Conn., U. S. A =Catalogue, 20 p. [Illustrating and describing seamless drawn, copper, range-boilers, seamless brazed brass and copper tubing and moulding, seamless drawn brass and copper shelves, brass kettles, plumbers' supplies, etc.]

H. M. Bates Machine Co., Boston and New York, U. S. A.=Catalogue, 160 p. [Machinery for transmission of power, pulleys, hangers, pillow blocks, friction clutches, counter-shafting, shippers, gears, and also a line of steam boilers and engines. Five pages of index; beautifully printed, octavo, flexible cover, olive green and gold.]

The J. D. Smith Foundry Supply Co., Cincinnati, Ohio, U. S. A.=Supplementary catalogue No. 22, 16 p. [Describing and illustrating tumbling barrels, exhaust pans, sand-blast apparatus, sand-blast tumbling barrel, etc.: with leaflets from other catalogues, describing radiant facings, pattern letters and figures, riddles, wire, wheels, brushes, &c.] Also Supplementary Catalogue No. 16, 8 p. [Describing and illustrating crowels, slicks, gate-knives, flutes, and other hand instruments for moulding.]

John S. Thurman, M. E., Indianapolis, Ind., U. S. A.=Catalogue, 3 pp. [Describes the Thurman's Oil Burning System, with illustrations of its applications to steam boiler forges, ovens for baking artificial teeth, brick kilns, ovens for drying sand, coal, marl, ores, infusorial earth, and other animal, vegetable, and mineral materials. Printed on coated paper. Cover maroon and gold.]

D. Van Nostrand Co., New York, U. S. A. =(1)Catalogue, 57 pp., 5½″ × 9″. [Contains a list, with prices, of the scientific, military and naval publications of this company, including Weale's Rudimentary Series.]

(2) Catalogue, 64 pp., 5½″ × 9″. [Contains a list, with prices, of the books on chemistry, chemical technology, and physics, published and sold by this company.]

(3) Catalogue, 64 pp., 5½″ × ″9. [Contains a list, with prices, of the books on electricity, electric light, the telephone, electro-motors, electric telegraph, electro metallurgy, &c., published and for sale by this company.]

Alberene Stone Co., Boston, Mass., U. S. A. =Catalogue, 32 pp., 10″×6½″. [Describes and illustrates a long line of soap-stone goods manufactured from the Alberene stone, derived from the quarries at Alberene, Va. Also contains price list. Elegantly printed on coated paper, with cover in pea-green, red and gold.]

Follansbee Bros. Co., successors to James B. Scott & Co., Pittsburg, Pa., U. S. A.=Pamphlet, 12 pp., 6″×6″. [Contains facsimiles and copies of letters received by this company, evidencing the high quality of "The Scott's Extra Coated" guaranteed roofing tin.]

Giblin & Co., Utica, N. Y., U. S. A.=Catalogue 20 pp., 4⅝″×7¼″. For dealers only. [Describes and illustrates the Furnaces and Combination Heaters manufactured by this Company. Cover blue and gold.] (2) Catalogue, 40 pp., 4⅝″×7¼″. For retail customers only. [Also describes the furnaces and combination heaters manufactured by this Company, but gives full explanation and directions to those who will erect and use them. Price list supplied in the first named catalogue.]

Marine Iron Works, Chicago, Ill., U. S. A.= Pamphlet, 32 pp., 6″×9″. [Describes a line of the marine machinery and complete steam yachts and launches manufactured by this Company, including several illustrations of engines, launch engines, marine engines, boilers in variety, the Roberts Safety water tube boiler, with illustrations of complete steam launches, and views of interiors of yachts, etc. The whole is handsomely printed and bound in pearl-gray cover.]

E. T. Barnum, Detroit, Mich., U. S. A.= Catalogue 120 pp., 7″×10½″. [Describes and illustrates a long list of wire and iron goods.]

The Ingersoll-Sergeant Drill Co., New York, U. S. A.=Catalogue, 115 pp., 10″×8″. [This is the 1895 coal mining catalogue No. 50, published by this company. It relates to coal-mining machines, air compressors, and general coal-mining machinery and appliances in great variety. A large number of the illustrations show the machines as in actual use,—a method of representation which greatly aids the reader in comprehending the value of these improvements. Price lists are also given.]

Hogan Boiler Co., Middletown, New York, U. S. A.=Twenty-five leaflets, eyeleted together, printed on one side only. [Each contains a plate illustrating different details of the construction and erection of the 400 h. p. Hogan boiler (manifold type) recently supplied to the State Homeopathic Asylum for the Insane, Middletown, New York.]

The Ferracute Machine Co., Bridgeton, New Jersey, U. S. A.=Catalogue 11, 1895, 32 fold-in pages, 12″×9¾″. [Illustrates and describes new designs of foot and power presses, lathes, beaders, dies, &c., for working various kinds of bar and sheet metals. Over 300 sizes and kinds of presses are described, and a number of them are illustrated. Tabulated information is also given.]

P. H. & F. N. Roots Co., Connersville, Ind., U. S. A.=Pamphlet, 18 pp., 10″×7″. [Describes and illustrates Roots' rotary positive pressure blower, with recent improvements. Gives table of specialties and capacities of blowers for cupolas, with principal dimensions of blowers and other useful information.]

New York Central Iron Works Co., Geneva, N. Y., U. S. A.=Catalogue 65 pp., 10″×6⅛″.

[Describes and illustrates the "Dunning" boilers, both of the magazine and surface burning types, showing the manner of their setting in brick, also illustrating and describing the portable boilers manufactured by this Company and giving price list.] (2) Catalogue of the Dunning Hot Water Heater. [Description and illustration of the hot water heaters manufactured by this Company for warming buildings. Elegant covers in olive green and gold.]

Anderson and Dickey, Boston, Mass., U. S. A.=Catalogue 52 pp., 5½″×8″. [Describes and illustrates an extensive line of architectural wood turning, spiral moulding, stair posts, baluster rails, etc.]

J. F. Pease Furnace Co., Syracuse, N. Y., U. S. A.=Catalogue 72 pp., 7″×10″. [Describes and illustrates the Economy Combination Heaters, steam heaters, hot water heaters, and warm air furnaces for which this firm has become famous. The combination system was succesfully originated by Mr. John F. Pease of this Company, and the first successful heater of the class was made and erected in 1882. Probably no heating device since invented has ever achieved a greater success than has this. A large portion of the catalogue is taken up in the way of testimonials from those who have used the goods put on the market by this firm. Tables of weight, dimensions, capacities, &c., are appended.]

T. C. Joy & Co., Titusville, Pa., U. S. A.=Pamphlet 40 pp., 9″×7″. [Describes and illustrates the radiators manufactured by this firm, together with engravings of large and important buildings in which these goods have been used. Elegantly printed, tinted engravings; cover, buff, pale green and deep violet.]

The Continental Iron Works, Brooklyn, N. Y., U. S. A.=Pamphlet, 24 pp., 9″×11″. Cover, stiff cloth, red and gold. [Describes and illustrates the Morison Suspension Furnaces; gives a long list of steamers using the furnaces; contains tables of pressure and thickness, with rules for calculating the same, as applied to the Morison Suspension Furnaces; plates, with full-size details of corrugation; diagram illustrating pipes of Morison Suspension Furnaces with plain ends, and also with flanged ends; diagrams illustrating interchangeable types of the Morison Suspension Furnaces; data necessary for estimating and for manufacturing purposes; diagrams illustrating types of flanging Morison Suspension Furnaces; and patent combustion chamber bottom, sectional diagrams, and end-views of land boilers fitted with Morison Suspension Furnaces, and the Morison Patent Furnace Door and Frame for marine and land boilers. A partial list of steamers to which the Morison Suspension Furnaces have been fitted fills four of the large pages of this pamphlet.]

The Ingersoll-Sergeant Drill Co., New York, U. S. A.=Advanced sheets of catalogue No. 40, 1895, 72 pp., 8″×10½″. [Describes and illustrates rock drills, quarry bars, gadders, stone-channeling machines, and special quarrying machines manufactured by this company. A large fund of useful information is contained within the covers. We are informed that the complete catalogue will be ready early the present season.]

Detroit Heating and Lighting Co., Detroit, Michigan, U. S. A.=Pamphlet, 56 pp., 6″×8″. "Light for Evening Hours." [The bulk of the book consists of a description of the combination gas machine manufactured by this company, with illustrations of many elegant buildings which are lighted by gas produced by the machine, which, though one of the oldest of its class, is fully up to date in the matter of sterling improvements which render its use satisfactory in every situation for which it is adapted. A catalogue of heating stoves and gas grates,—of which the company manufacture a long line,—as well as of the necessary fixtures for burning manufactured or natural gas, cooking utensils for use with stoves, etc., is appended. A leaflet describing the combination mixing regulator used with perfect success in gas-ranges, gas-logs, etc., is inserted. Another leaflet containing an important testimonial relating to the availability of the gas manufactured by the combination gas machine above spoken of for use with the Wellsbach system of incandescent lighting, also accompanies the catalogue. Like all the trade publications issued by this company, this pamphlet is elegantly printed and illustrated with beautiful half tone and line engravings and bound in an elegant cover,—canary-yellow and dark blue.]

The Deane Steam Pump Co., Holyoke, Mass., U. S. A.=(1) Catalogue, 12 pp., 8″×4″. [Describing the Deane pumping apparatus for artesian wells.] (2) Catalogue, 8 pp., 3½″×6″. [Describing the Deane automatic receiver.] (3) Catalogue, 16 pp., 3½″×6″. [Describing and illustrating the Deane specialties, including latest and most improved designs of their special classes of pumps.] (4) Catalogue, 8 pp., 3½″×6″. [Describing and illustrating the Deane triplicate power pumps.]

Orr & Sembower, Incorporated, Reading, Pa., U. S. A.=Catalogue J, 1895, 86 pp., 3″×6″. [Describes and illustrates vertical, horizontal, marine, and hoisting engines and boilers in great variety, with price list. Cover, buff and light brown.]

The Hayden & Derby Mfg. Co., New York, U. S. A.=Catalogue, 32 pp., 6″×9½″. [Metropolitan Injectors, and also some well-compiled and -prepared information in reference to injectors in general, with descriptions and illustrations of the Metropolitan injectors and price list.]

The Cincinnati Corrugating Co., Piqua, O., U. S. A.=Illustrated catalogue, 1894. 63 pp., 6″×9″. [Describing corrugated roofing, siding, ceiling, arches, lath, shutters and doors, V-crimped iron roofing, standing seam plain roofing, roll and cap steel roofing, Outcalt elastic joint roofing, metallic weather bars, ridge capping, peaked metallic ceiling and roofing tin plates, and Juniata galvanized sheets "Piqua brand." Cover, black and gold.]

The Cady Mfg. Co., Cleveland, O., U. S. A.=Catalogue, 24 pp., 3⅜″×6″. [Describing

and illustrating a long line of machine tools for forging, punching, shearing wire, work, sheet metal work, etc. Cover, blue and gold.]

Richardson & Boynton Co., New York, U. S. A.=Pamphlet, 7 pp., 6"×9". [Describes and illustrates the new "Perfect" hot air blast for boiler furnaces, patented and placed on the market by this house. Very remarkable claims for the economy secured by the use of this system are made. A perfect comprehension of the application of the device may be gained from the pamphlet.]

Murray & Tregurtha, South Boston, Mass., U. S. A.=Catalogue, 39 pp., 9"×6". [Describing and illustrating steam yachts and launches, the Tregurtha water tube boilers, single, combined, triple, and quadruple expansion marine engines, propeller wheels, etc.]

The Jeffrey Mfg. Co., Columbus, O., U. S. A. =Catalogue, 144 pp., 5"×7½". [Describing and illustrating chain belting, steel cable conveyors, labor-saving appliances, elevators, carriers, power-transmission machines, mill, factory and mine supplies, and mining machinery. [Cover, pearl-gray and blue.]

The Dunn Mfg. Co., Limited, Pittsburg, Pa., U. S. A.=Catalogue, unpaged, 6"×9". [Describes and illustrates the extensible sewer brace manufactured by this company, and also a line of special tools for contractors' use. Cover, salmon-yellow and violet.]

William T. Comstock, New York, U. S. A.= Catalogue, 66 pp., 6"×9". [Comprising a list of a long line of standard architectural and building books, together with numerous other technical publications sold by this house. The list is especially copious in works pertaining to architecture and building.]

Dennison Mfg. Co., Boston, Mass., U. S. A. =Pamphlet, 61 pp., 6" × 9¼". [Beautifully printed on coated paper with portrait of E. W. Dennison, founder of the company, and a history of the business and of the principal men concerned in it, with portraits, views of buildings, &c. An interesting feature is an account of a distribution made to every employee on the fiftieth anniversary of the existence of the company, amounting to $5 for every full year's service, together with a certificate recognizing valuable services rendered.]

B. F. Sturtevant Co., Boston, Mass., U. S. A. =Pamphlet, 20 pp., 6½"×8½". [Describing the system of mechanical draft as contrasted with chimney draft, and describing and illustrating the various fan-blowers manufactured by this company for the purpose of producing either forced draft or induced draft, with a list of some of the numerous parties using these appliances. Very neatly printed on good paper with clear illustrations.]

Chas. P. Willard & Co., Chicago, Ill., U. S. A.=Pamphlet, 32 pp., 6"×9". [Describing and illustrating fore and aft compound engines, compound marine engines, steam yachts, yacht engines, steeple compound engines, steam launch and launch engines, the Willard high-speed marine engine, duplicate marine engine, plain vertical boilers, submerged tube vertical marine boilers, the Clyde boiler, Scotch marine boilers with water backs, stern-wheel river launch, long-stroke marine engines for stern-wheel boats, feathering paddle wheels, light draft, twin-screw launches, steamer steering wheels, propeller wheels, condensers, and yacht appliances in great variety.]

The Meriden Machine Tool Co., Meriden, Conn., U. S. A =(1) Illustrated catalogue and price list, 1895. 32 pp., 6"×9". [Five pages are left blank, except that the title of the company and the word "Notes" are printed at the top. Describes a line of machine tools, particularly lathes and lathe appliances, turret lathes, self-oiling counter shafts, drill presses, universal joints, etc., manufactured by this company.] (2) Pamphlet, 6"×3⅜", entitled "Selections from the Poets (and others), with comments." [This is one of the most unique bits of trade literature that has come under our notice. The name of the firm which perpetrates this pleasant joke appears nowhere except on the very last page, whereon is written the sentence; "The perpetrator hopes to be forgiven; an order for (or even an inquiry regarding) a forming lathe will be accepted as evidence of forgiveness." The signature of the firm is appended to this plea.]

M. Mahony, Troy, N. Y., U. S. A.=Catalogue, 19 pp., 8"×6". [Describing the line of Mahony vertical section boilers for steam or hot water. Printed on heavy coated paper in separate sheets, eyeletted together with pink cord, which attaches a cover of beautiful design in pearl-gray and black.]

The Ludlow Valve Mfg. Co., Troy, N. Y., U. S. A.=Catalogue, 106 pp., 8⅜"×5". [Describing and illustrating the long line of Ludlow valves and Ludlow hydrants which this company has been putting on the market for many years. Tables of dimensions and price-list are included. Flexible leather cover.]

Sandwich Enterprise Co., Sandwich, Ill., U. S. A.=Catalogue, 64 pp., 6"×9". [Illustrating and describing, with price list, a long line of wind-mills, wind-mill towers, tanks, pumps, and other hydraulic appliances; also leaflet describing the new ærating pump manufactured by this company for use in purifying pump water, and containing opinions of users as to its efficiency.]

Link-Belt Engineering Co., Philadelphia, Pa., U. S. A.=Catalogue, 19 pp. [Describing power-transmission machinery, including shafting, pulleys, gearing, rope sheaves, fly wheels, friction clutches, general machinery casting, etc., etc., which this company supplies and contracts for, as well as complete power equipments and manufacturing plants of every description. Cover, old gold and purple.]

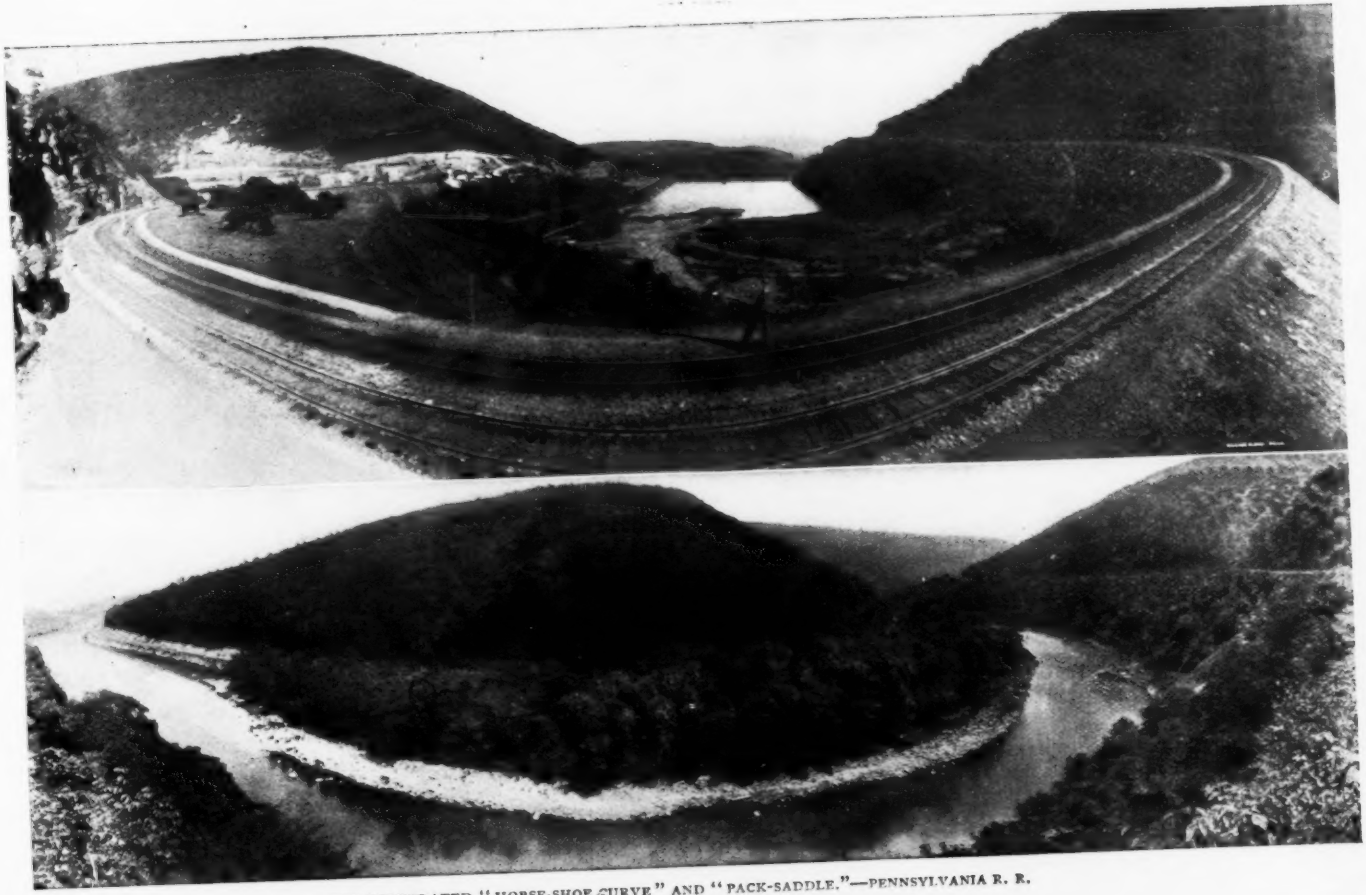
B. F. Sturtevant Co., Boston, Mass., U. S. A.=Illustrated Catalogue, 27 pp., 8½"×6½". [Describing the Sturtevant automatic upright engines for electric light and general high-grade work. This is beautifully printed on coated paper; cover, dark pink, rose-pink and gold.]

For additional Catalogues see pages under Improved Machinery.

FAMOUS SCENERY

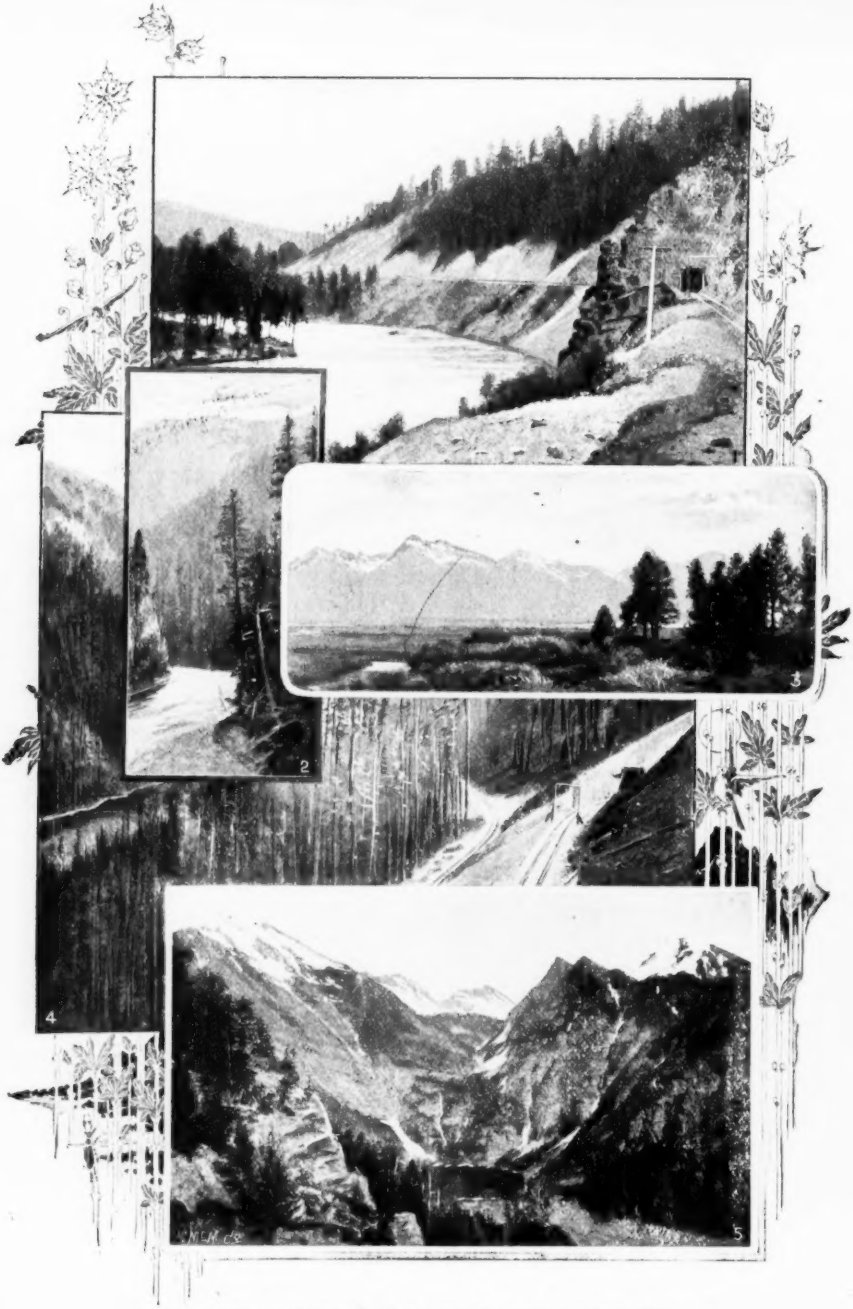
ON

AMERICAN RAILROADS.



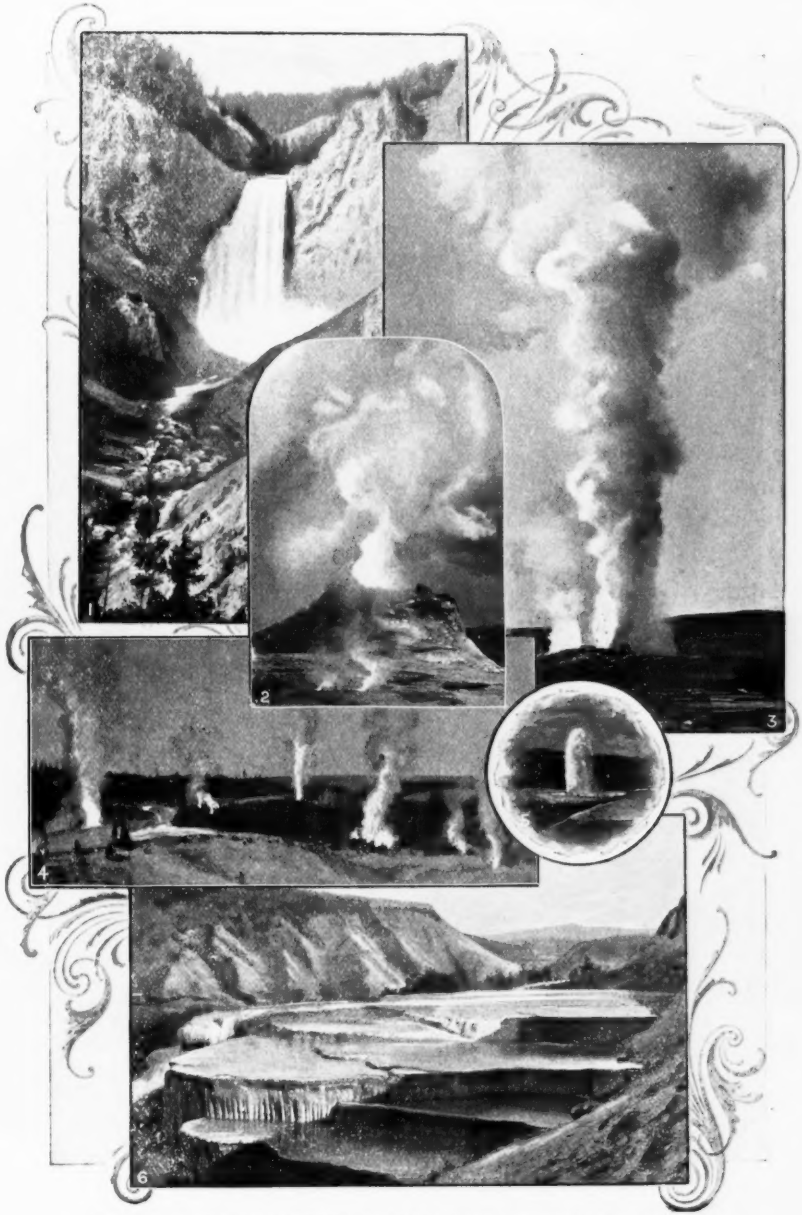
THE CELEBRATED "HORSE-SHOE CURVE" AND "PACK-SADDLE."—PENNSYLVANIA R. R.

DISTANT VIEW OF MOUNT RAINIER.—NORTHERN PACIFIC R. R.



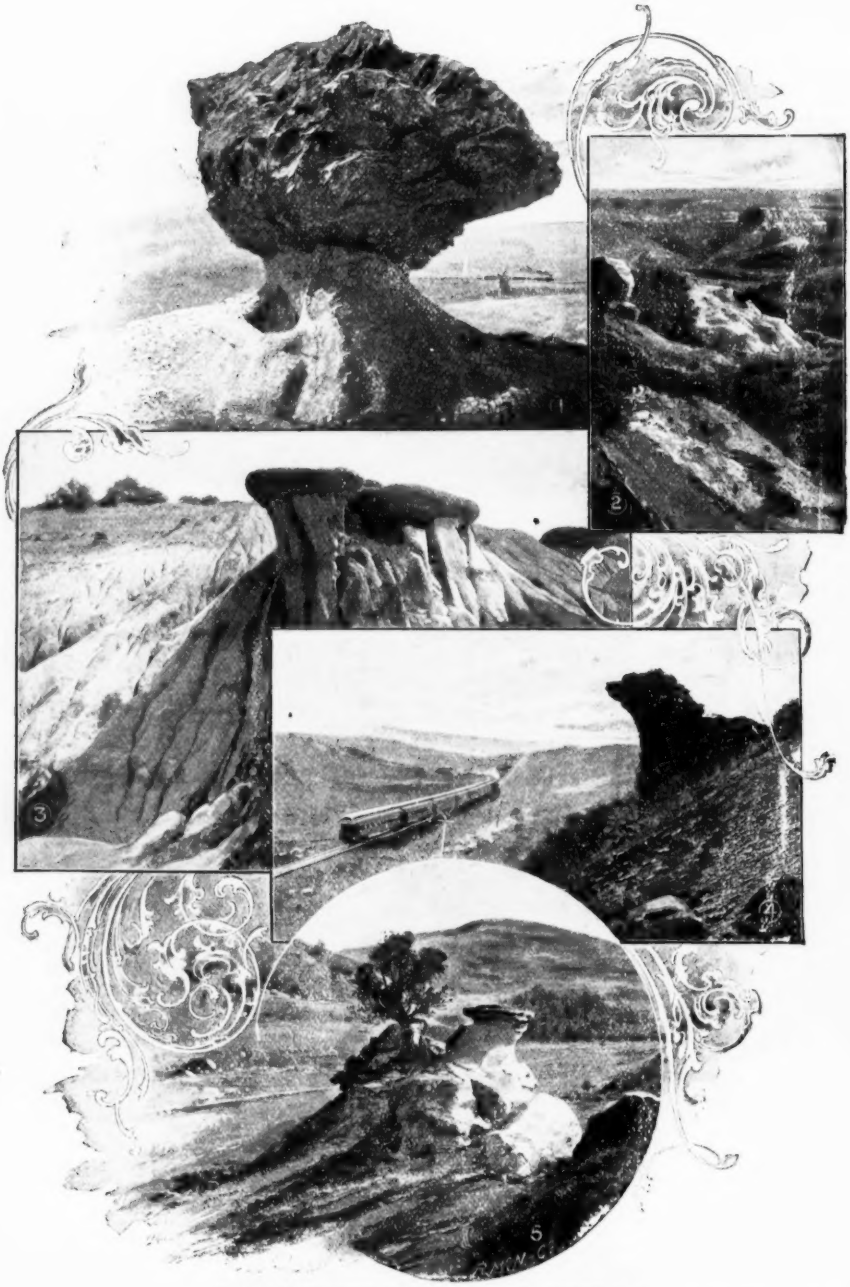
IN FLATHEAD AND COEUR D'ALÉNE COUNTRY.—NORTHERN PACIFIC R. R.

1. Along the Missoula River. 2. St. Regis River. 3. Mission Range. 4. On St Regis River.
5. Pumpelly Cañon—McDonald Peak—Mission Range.



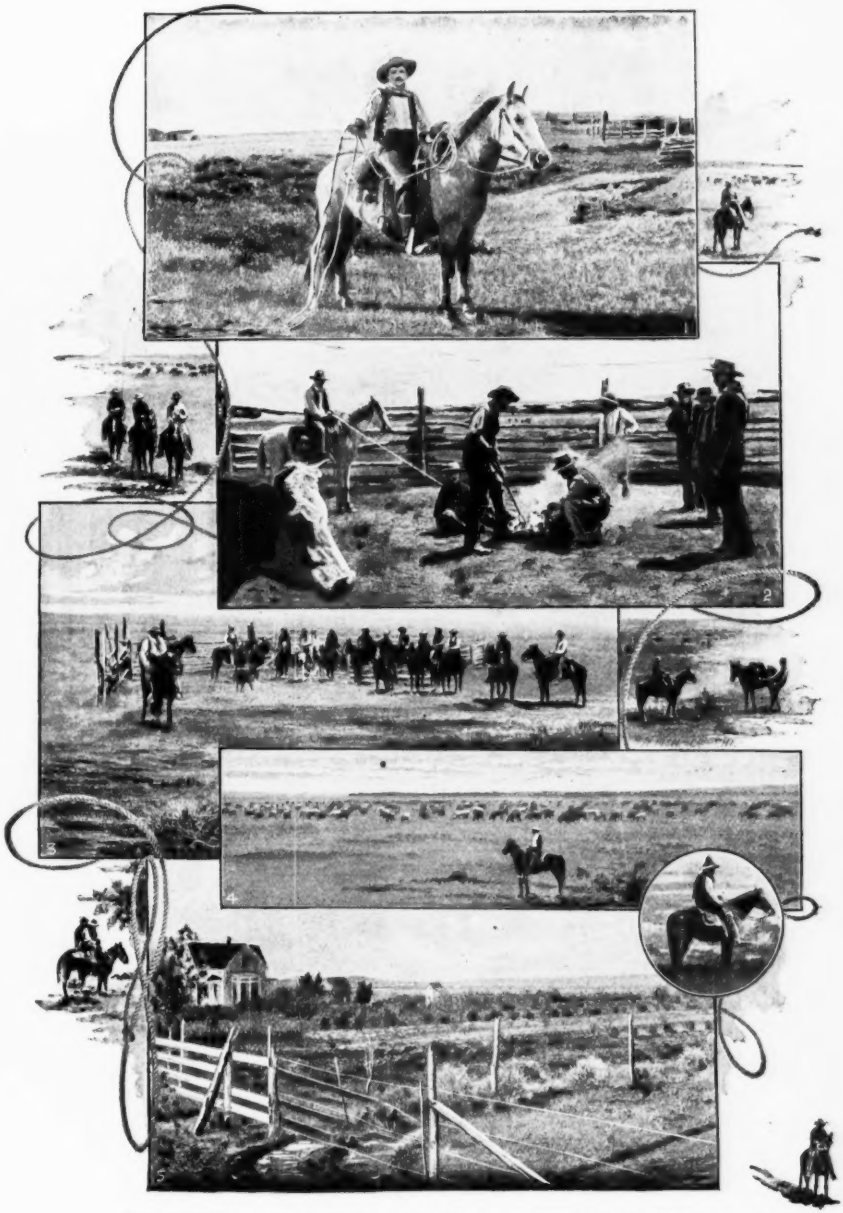
SCENERY IN THE YELLOWSTONE NATIONAL PARK.—NORTHERN PACIFIC R. R.

1. Yellowstone Falls and Cañon. 2. Castle Geyser. 3. Giant Geyser. 4. Norris Geyser Basin.
5 Bee Hive Geyser. 6. Minerva Terrace.



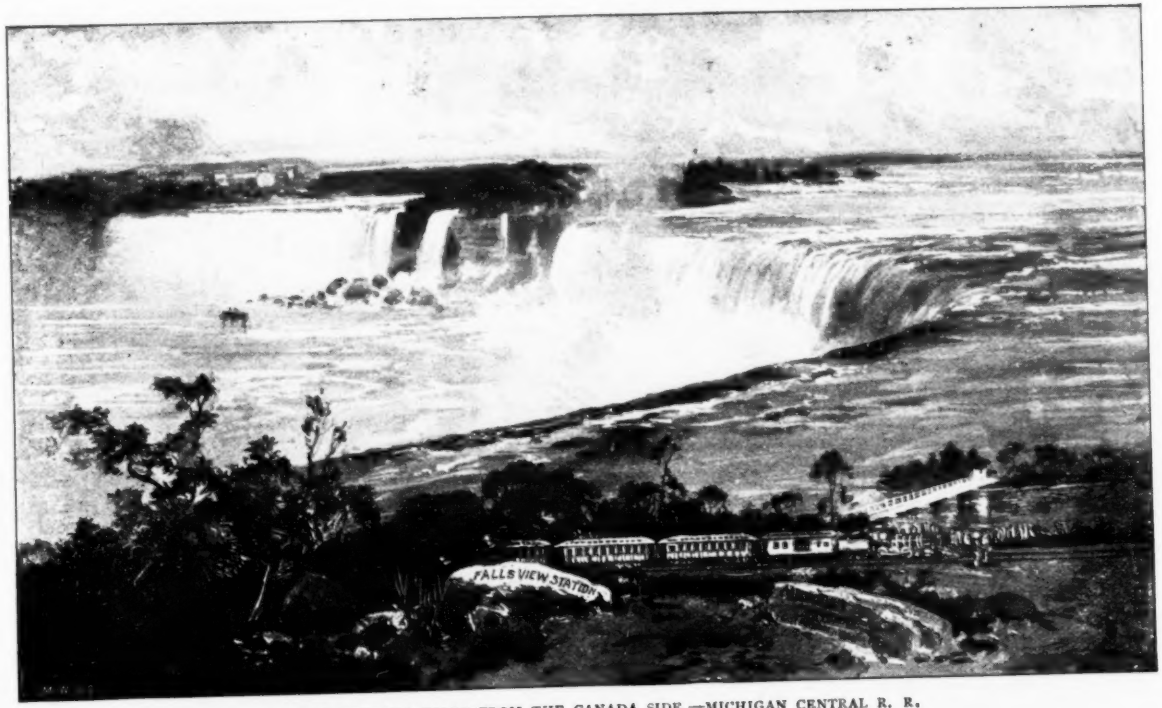
SCENES IN PYRAMID PARK.—NORTHERN PACIFIC R. R.

1, 2, 3, 5. Scenes Along Little Missouri River. 4. Watch Dog Rock.

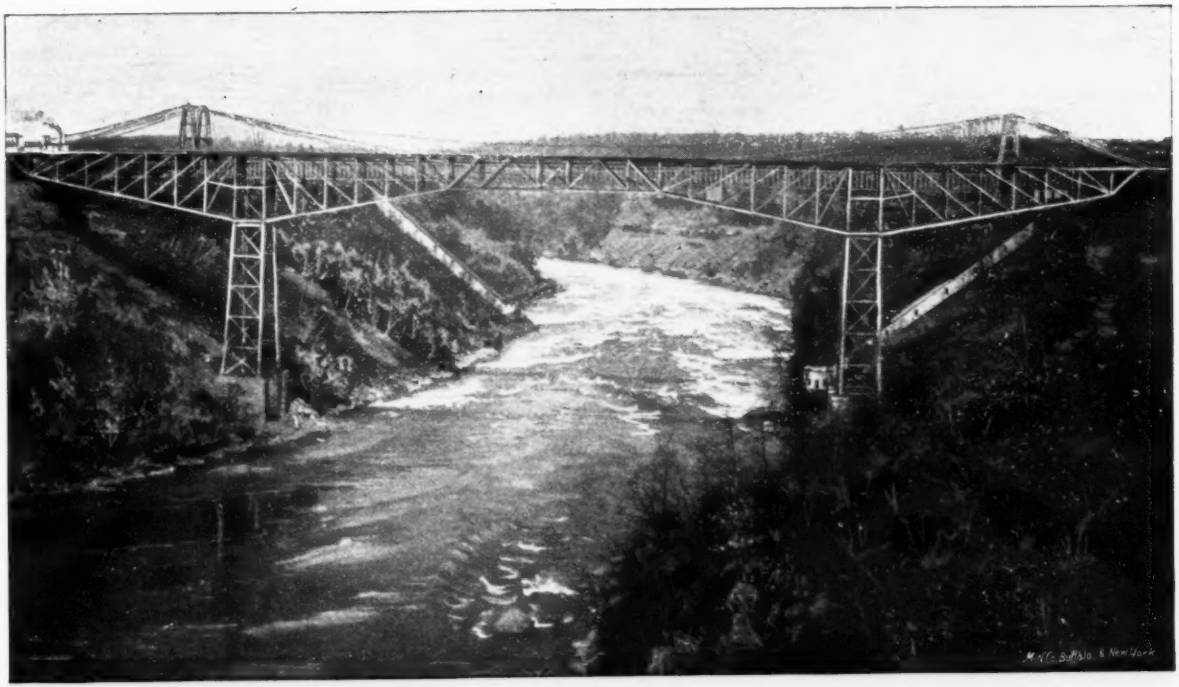


RANCH SCENES IN THE YELLOWSTONE VALLEY.—NORTHERN PACIFIC R. R.

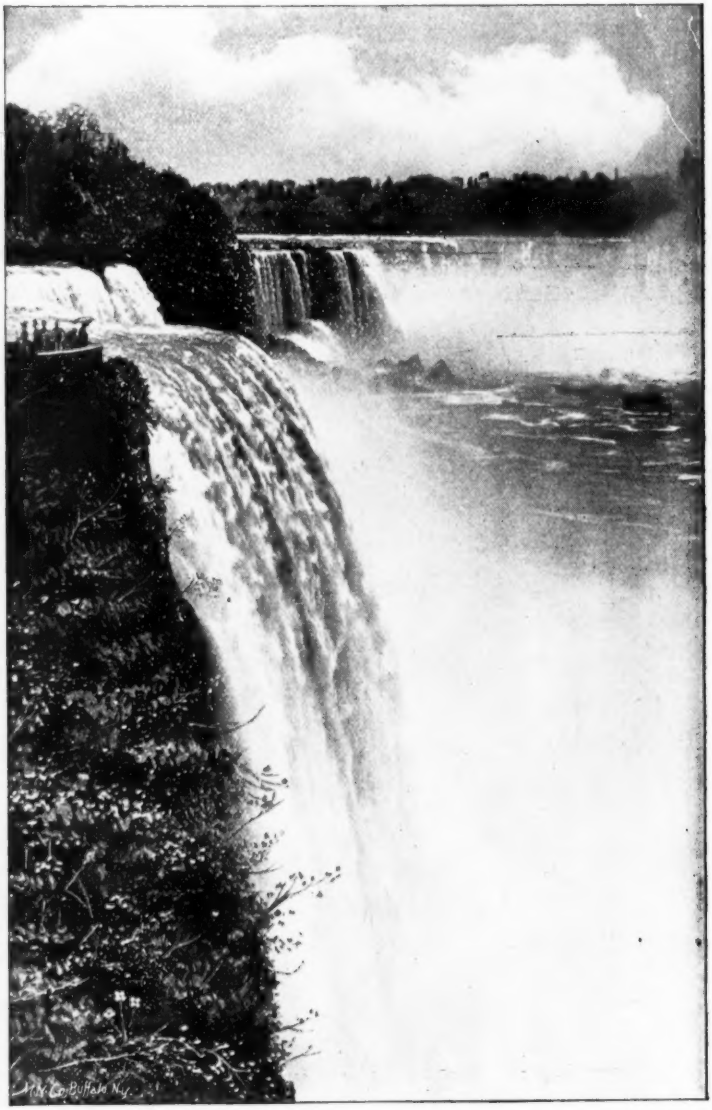
1. Typical Cow Boy. 2. Branding. 3. Cow Boys.
4. Herding. 5. Cattle Ranch.



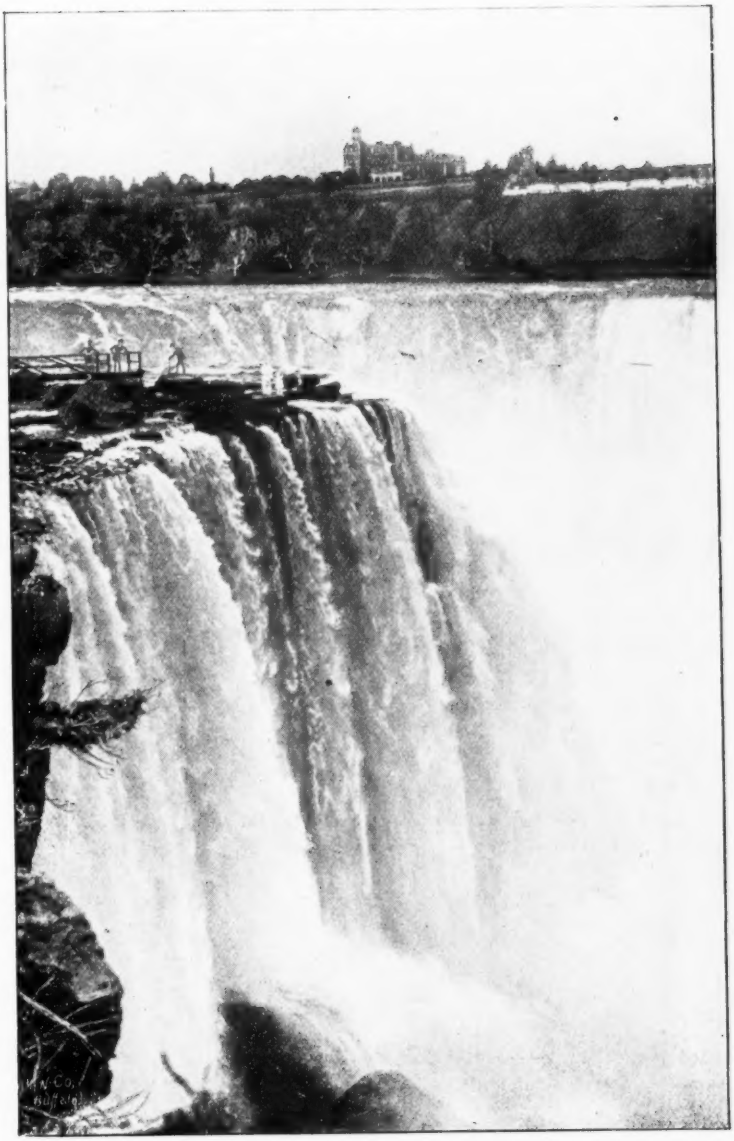
VIEW OF NIAGARA FALLS FROM THE CANADA SIDE.—MICHIGAN CENTRAL R. R.



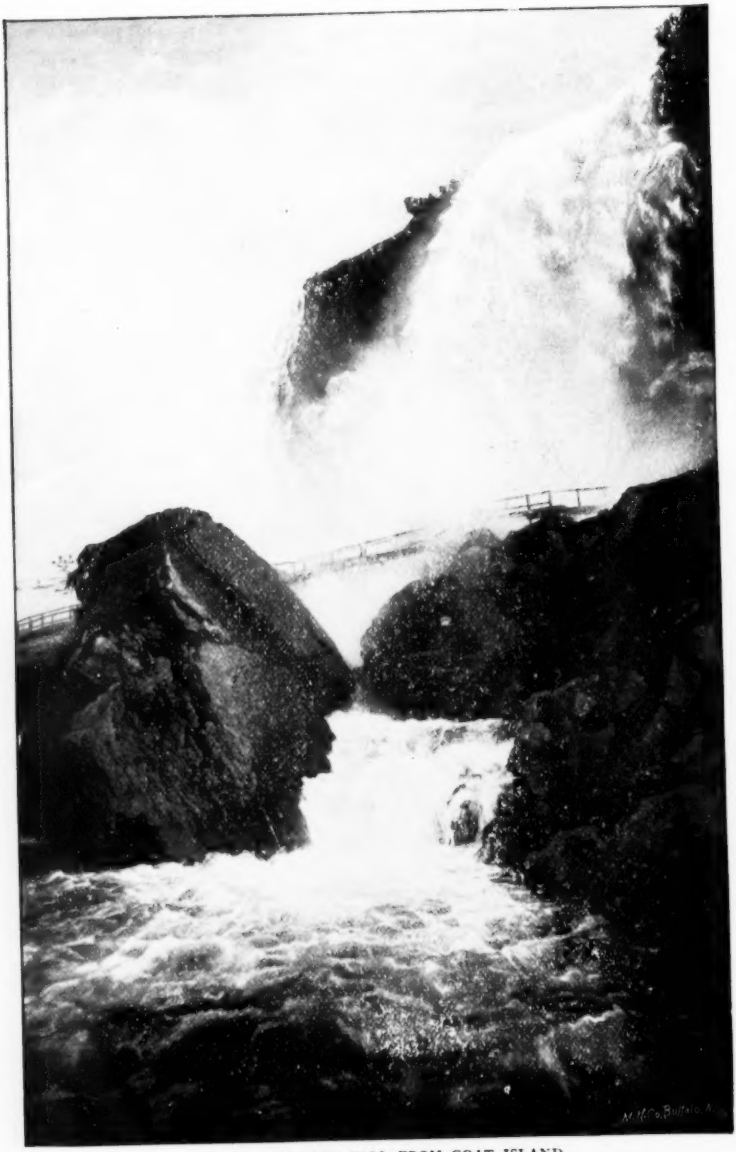
THE CANTILEVER BRIDGE OF THE MICHIGAN CENTRAL AT NIAGARA FALLS.



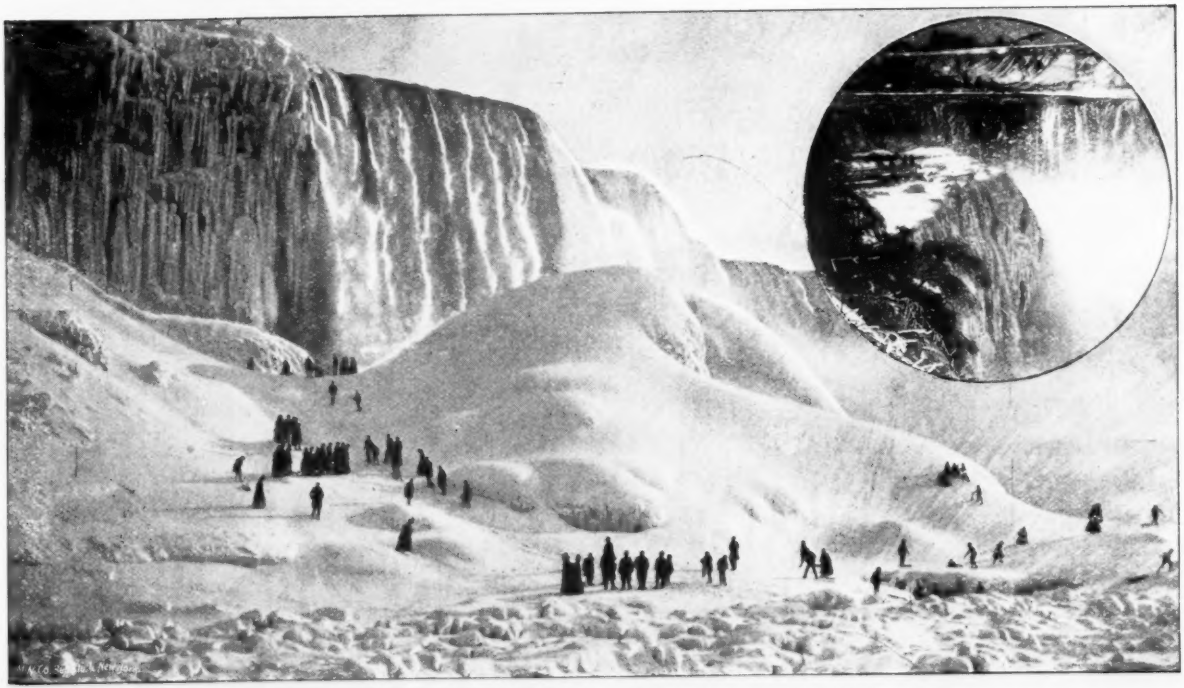
GENERAL VIEW OF THE FALLS FROM PROSPECT POINT.



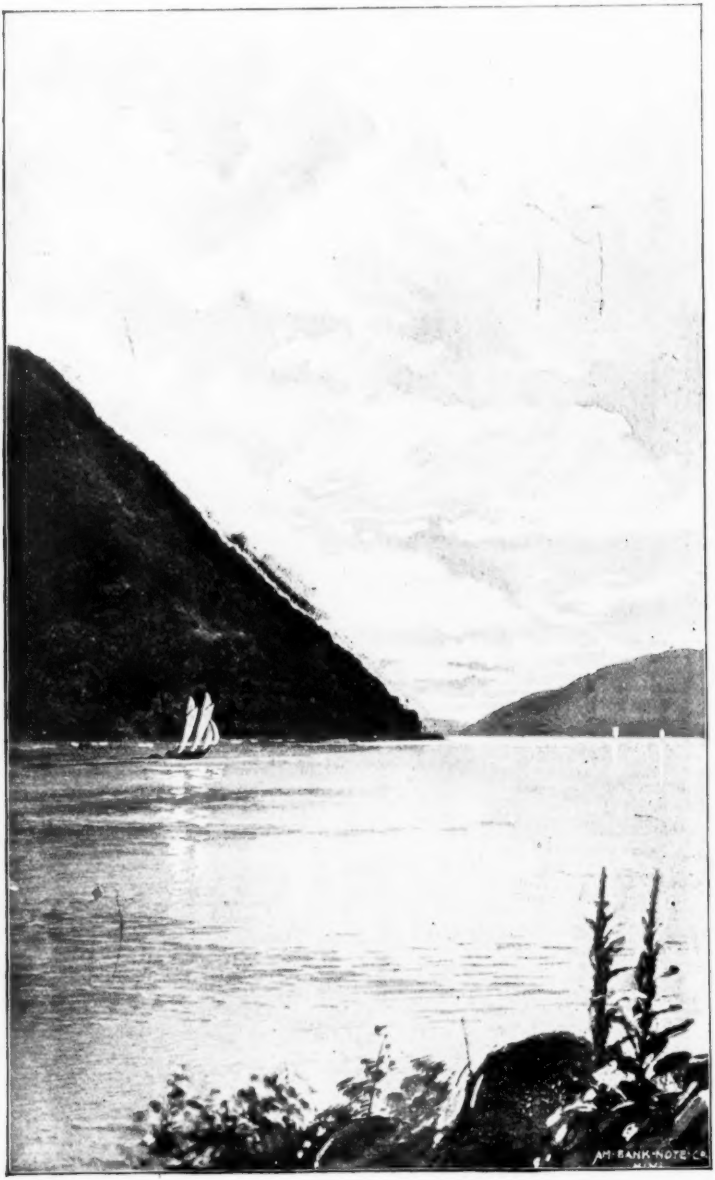
THE AMERICAN FALLS FROM BELOW GOAT ISLAND.



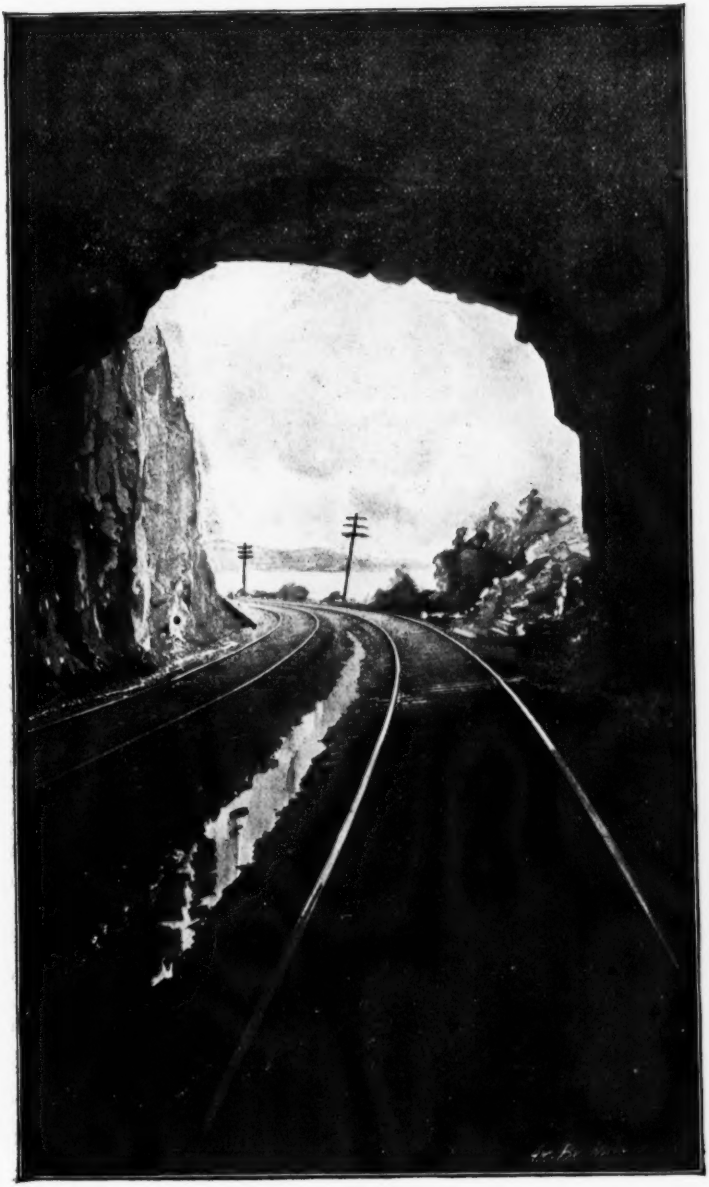
THE HORSE-SHOE FALL FROM GOAT ISLAND.



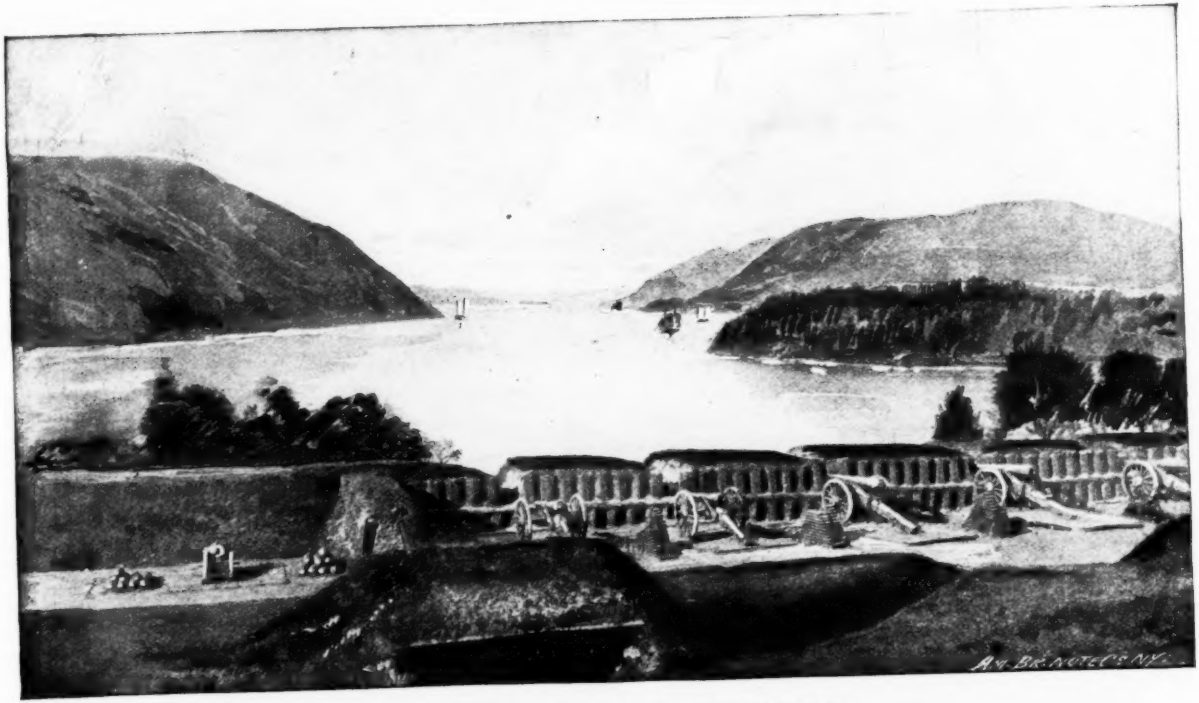
IN WINTER GARB. ICE MOUNTAIN, FOOT OF AMERICAN FALL, AND THE HORSE-SHOE.



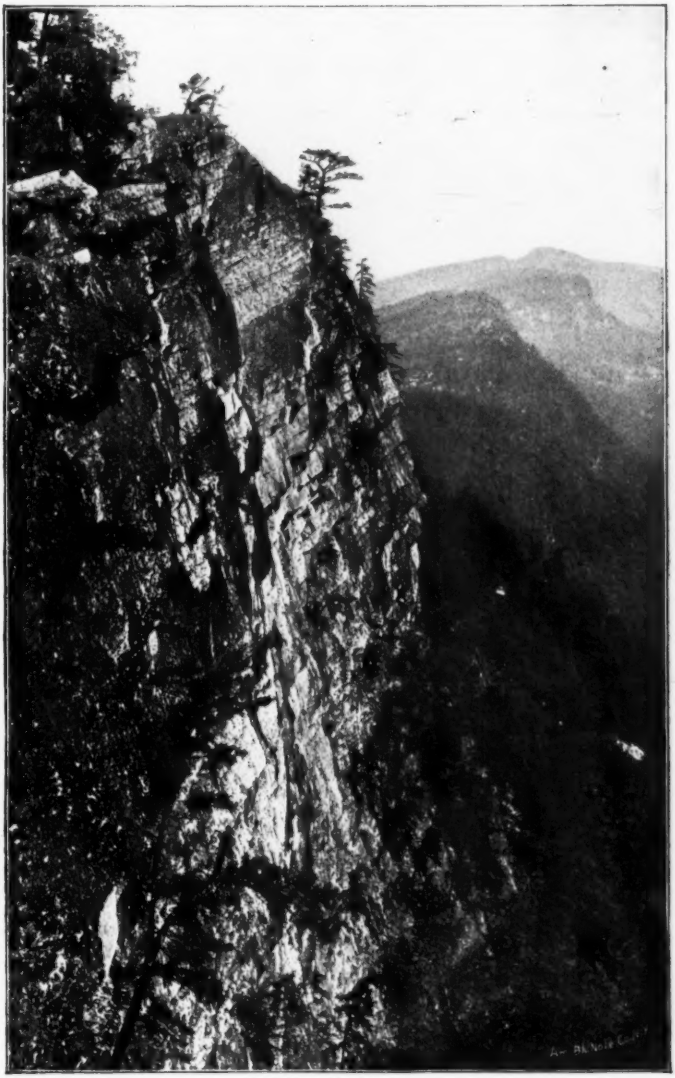
ANTHONY'S NOSE FROM FORT MONTGOMERY, ON THE HUDSON.



LOOKING OUT OF HAVERSTRAW TUNNEL.—WEST SHORE AND ONTARIO & WESTERN R. R.



LOOKING NORTH FROM WEST POINT.—WEST SHORE R. R.

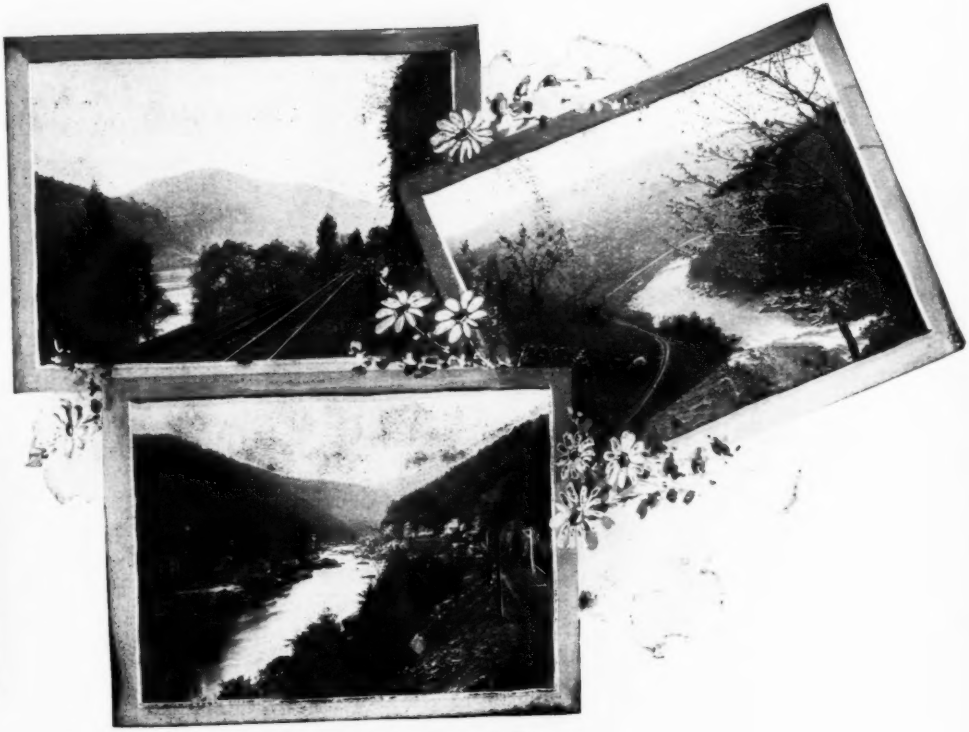


CREST OF THE SHAWANGUNKS, CATSKILL RANGE,—N. Y., ONTARIO & WESTERN R. R.

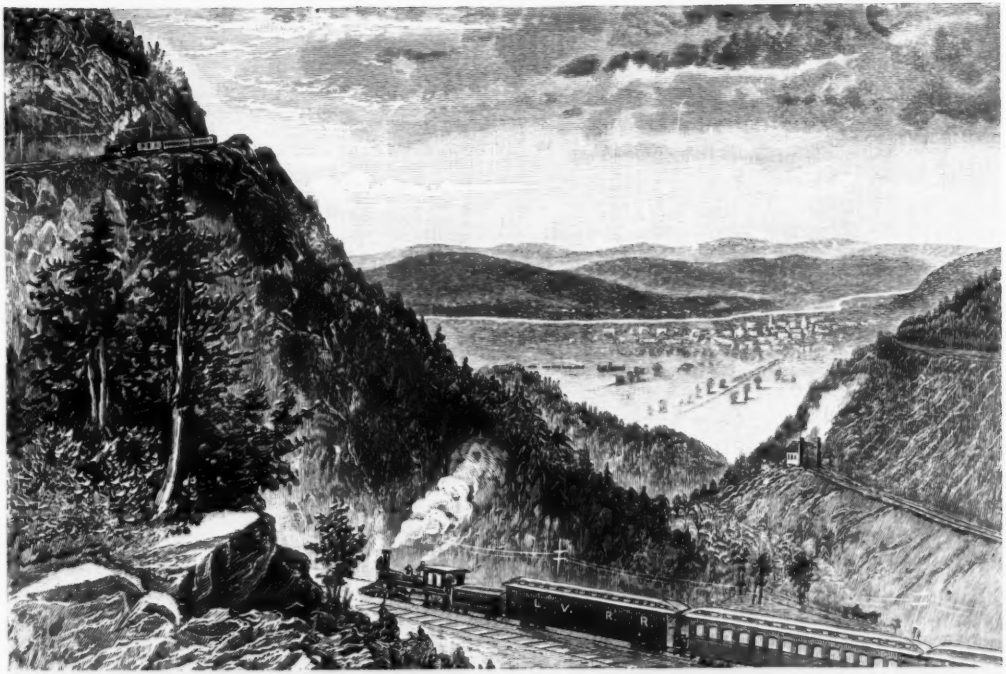
ON THE "SWITCHBACK" IN CASCADE MOUNTAINS, WASHINGTON.—GREAT NORTHERN R. R.

A CATTLE RANCH IN MONTANA.—GREAT NORTHERN R. R.

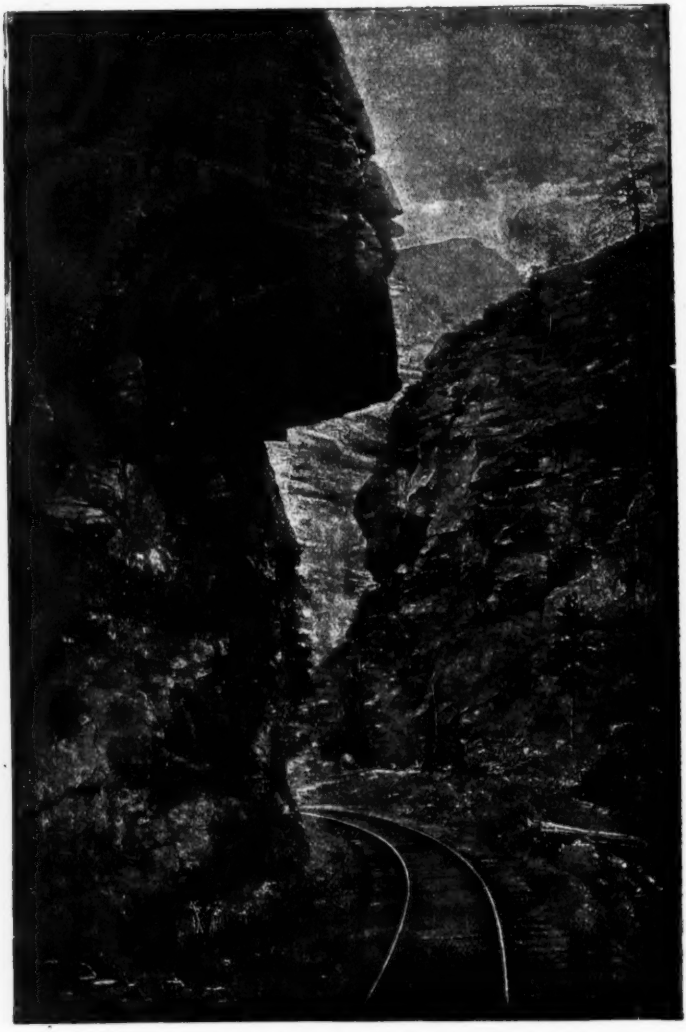
ROA HOOK, ON THE HUDSON.—SITE OF THE STATE CAMP, NEW YORK MILITIA.—NEW YORK CENTRAL R. R.



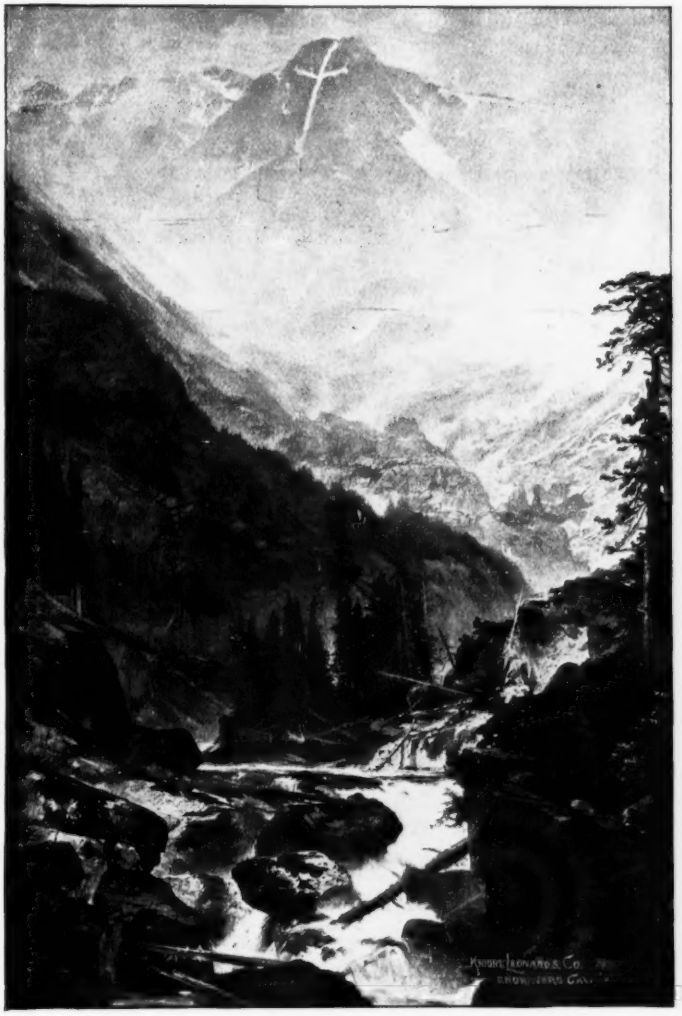
IN THE BLUE RIDGE MOUNTAINS.—CHESAPEAKE & OHIO R. R.



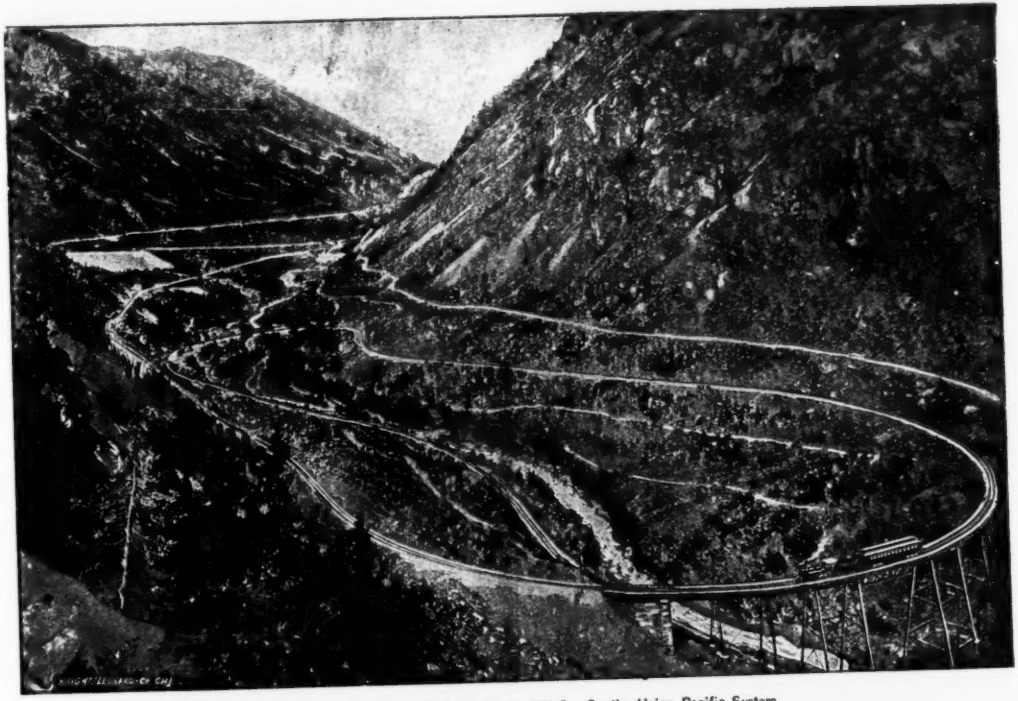
THE WYOMING VALLEY, PA.—LEHIGH VALLEY R. R.



HANGING ROCK, CLEAR CREEK CANON—On the Union Pacific System.

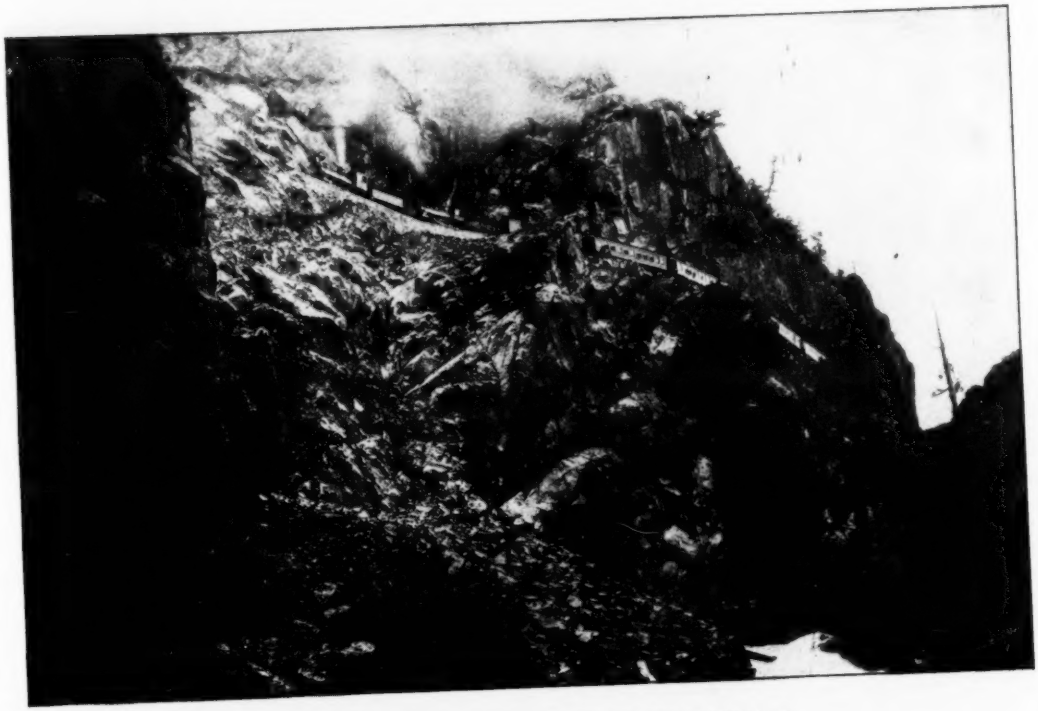


MOUNT OF THE HOLY CROSS, COLORADO.—seen from the Union Pacific System.

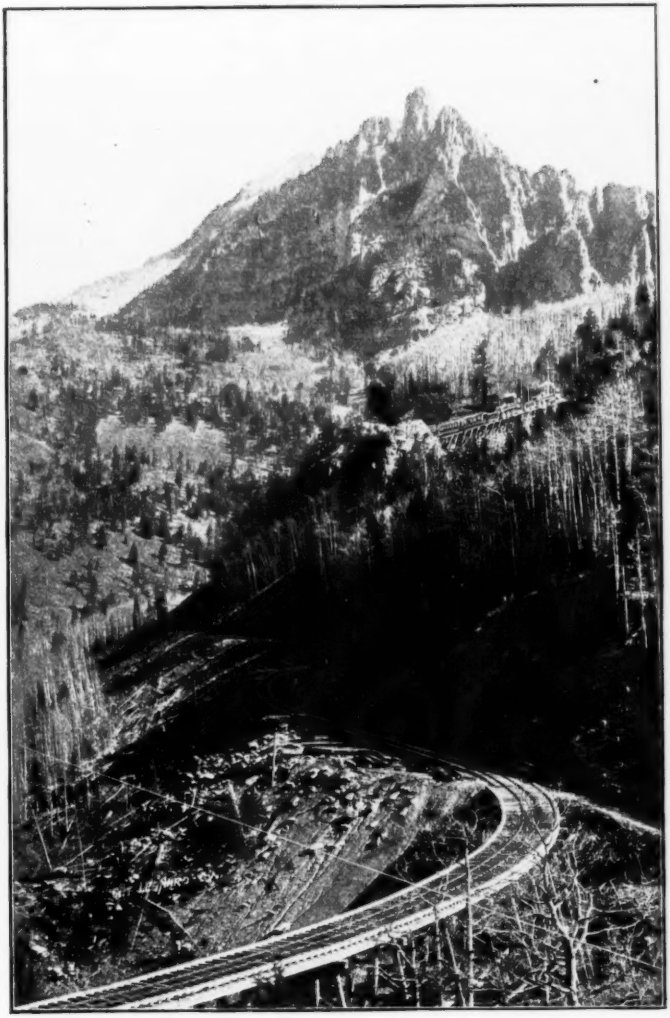


THE LOOP ABOVE GEORGETOWN, COLO.—On the Union Pacific System.

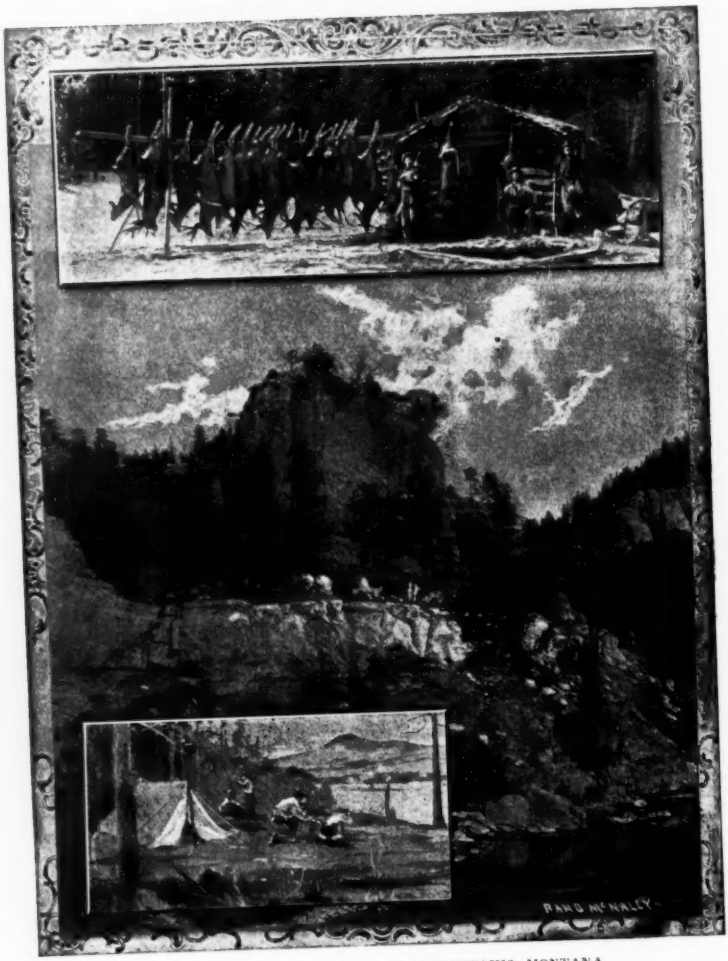
MOUNT ABRAM, OURAY TOLL ROAD.—COLO.



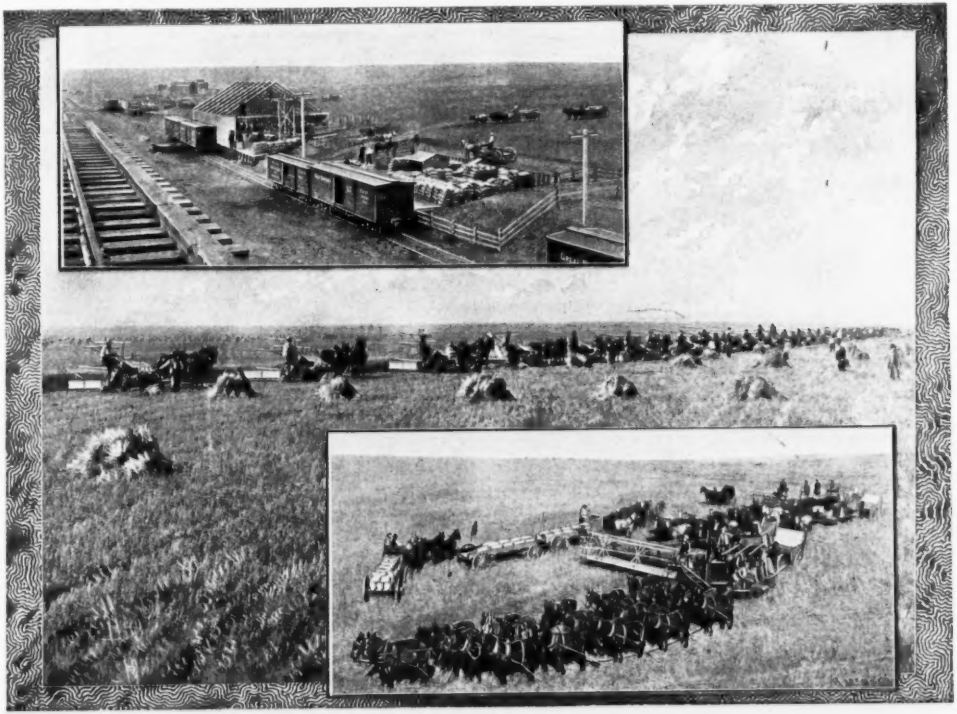
RIO LAS ANIMAS CANON, COLO.—DENVER AND RIO GRANDE R. R.



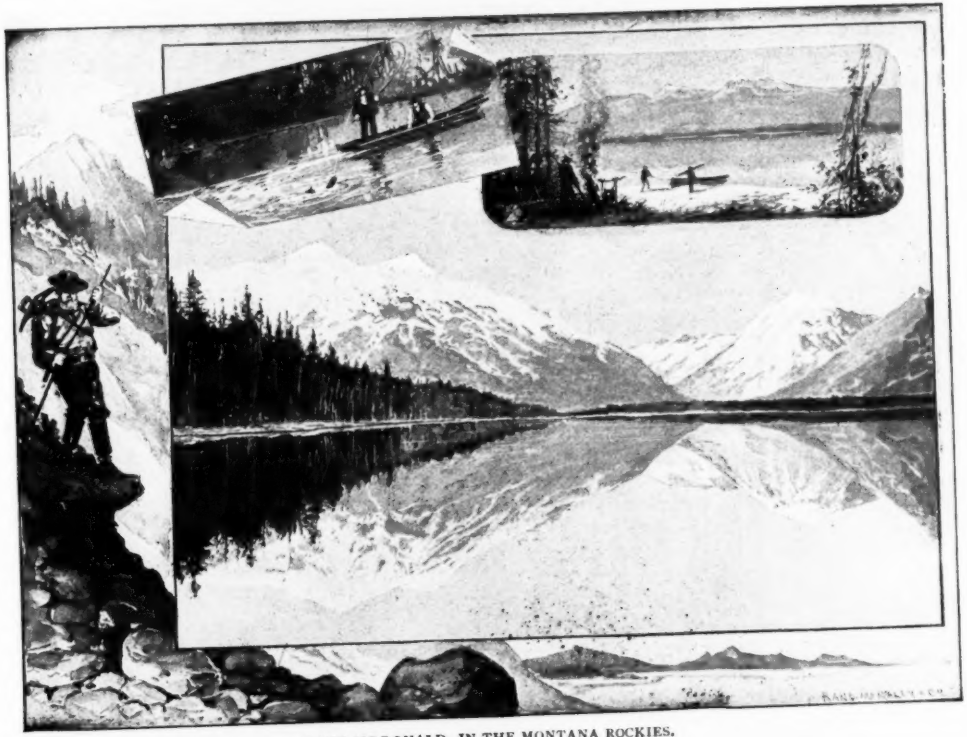
CATHEDRAL SPIRE, COLO.—DENVER AND RIO GRANDE R. R.



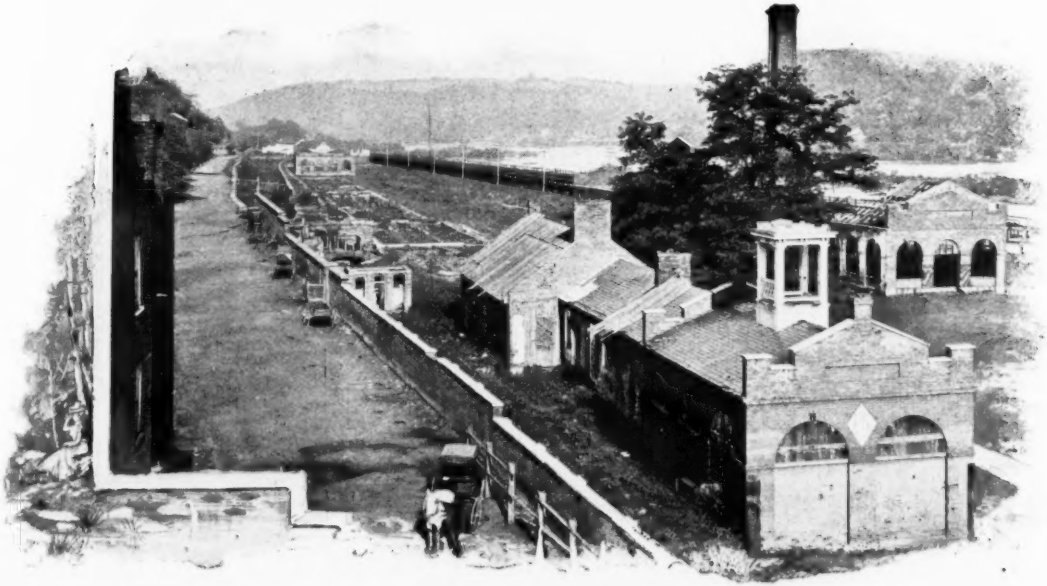
BELT RIVER VALLEY IN BIG BELT MOUNTAINS, MONTANA.



IN THE BIG BEND WHEAT COUNTRY, WASHINGTON.

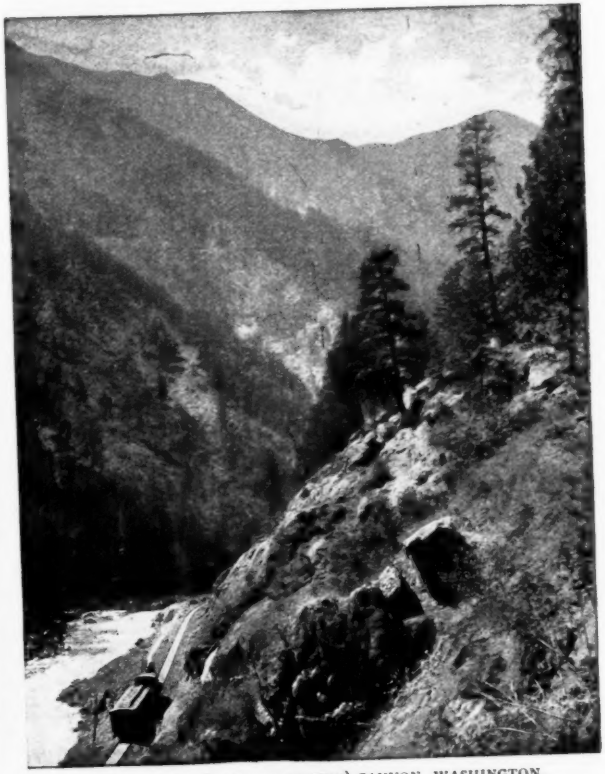


LAKE MC DONALD, IN THE MONTANA ROCKIES.



JOHN BROWN'S FORT AND THE OLD ARSENAL, HARPER'S FERRY, WEST VA.—BALTO. AND OHIO R. R.

PROFILE ROCK, CASCADE MOUNTAINS, WASHINGTON.



IN TUMWATER (TALKING WATER) CANYON, WASHINGTON.

GREAT NORTHERN RAILROAD.